















**RECORDS OF THE  
WESTERN AUSTRALIAN  
MUSEUM**



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**Volume 7, Parts 1-4  
1979**

# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

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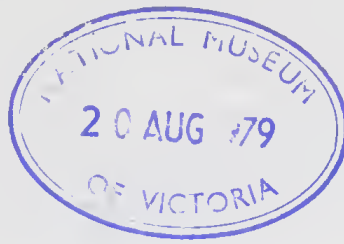
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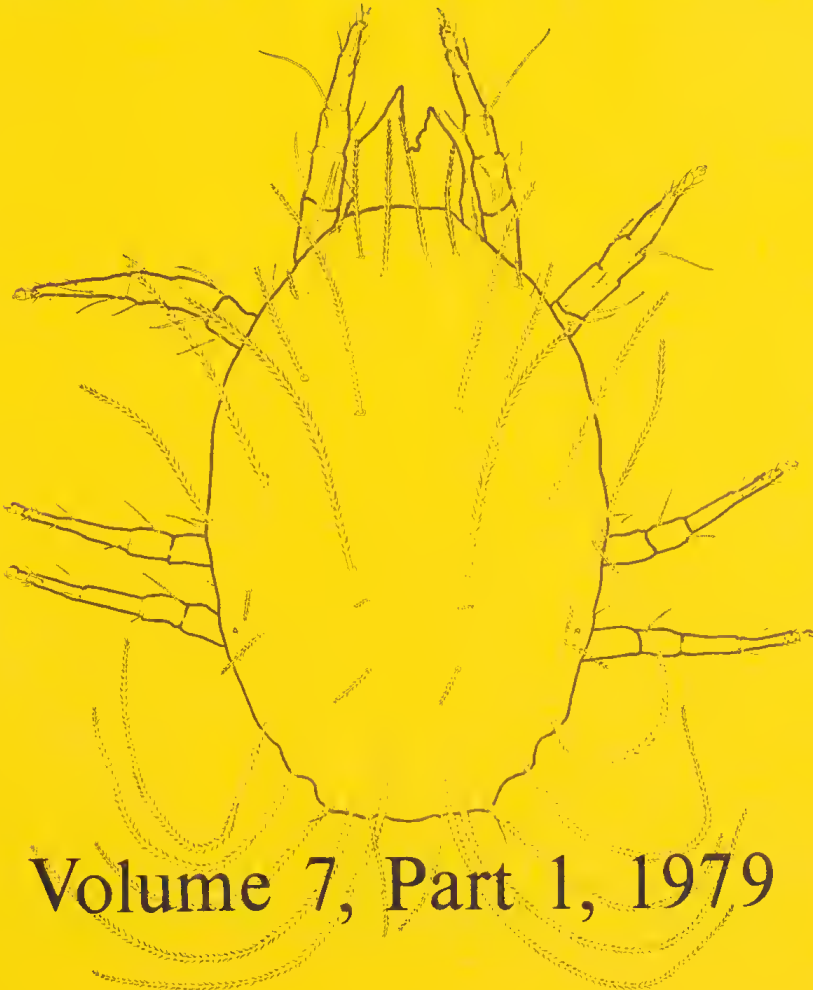
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# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM



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Cover: The tritonymphal stage of a parasitic mite, *Marsupiopus zyzomys*. The hypopial stage of this mite lives in the hair follicles of the tail of the Common Rock Rat (*Zyzomys argurus*) which in Western Australia occurs in the Pilbara and Kimberley regions.

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## PARASITES OF WESTERN AUSTRALIA

### I

## HYPOPI OF THE FAMILY HYPODERIDAE MURRAY, 1877

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and

A. FAIN†

[Received 20 May 1977. Accepted 16 November 1977. Published 26 February 1979.]

### ABSTRACT

Two new species of heteromorph deutonymphs (hypopi) from Australian hosts (living under the skin of birds) are described and figured. For the first species collected from a caprimulgiform bird a new genus *Caprimuldectes* has been erected.

### INTRODUCTION

Hypopi of family Hypoderidae live in the connective tissues under the skin of birds. During the breeding period hypopi leave their hosts and molt in the nest directly to adults. From the eggs free hypopi emerge and penetrate the soft skin of nestlings. In the connective tissue under the skin and around the trachea and oesophagus (and in strongly parasitized birds also around the lungs and heart), hypopi gorge an increase much in size although their mouthparts and mouthopenings are absent. Free hypopi and tissue hypopi have the same sclerotized parts such as legs, setae and shields. They differ however, in leg to body proportions. The life cycle is shortened by suppression of the larval, protonymphal and tritonymphal stages. Development is closely related to the generation cycle of the hosts. Hormonal changes in the hosts seem to be important (Fain 1967). Observations of hosts in zoological gardens indicate that infection by large numbers of mites results in serious illness or death. Representatives of the family are not yet

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recorded from Western Australia. Remarks are given below on the hypopi collected in three birds by one of us (F.S.L.) during the Western Australia Field Program 1976.

1 *Hypodectes (Hypodectoides) propus bubulci* Fain, 1967<sup>1</sup>

The subspecies was first described from *Bubulcus ibis* by Fain and Hyland 1962. Specimens were found in *Ardea herodias cognata* from the Galapagos Islands and in *Tantalus leucocephalus* which died in the zoological garden at Vienna (Fain 1967). Cerny (1969) found them in *Ardeola ibis* and *Florida caerulea* from Cuba. All the above hosts belong to the Ciconiiformes.

We found larger numbers of hypopi in *Egretta garzetta* (Ardeidae: Ciconiiformes), Napier Downs, 3 September 1976, Lukoschus leg.

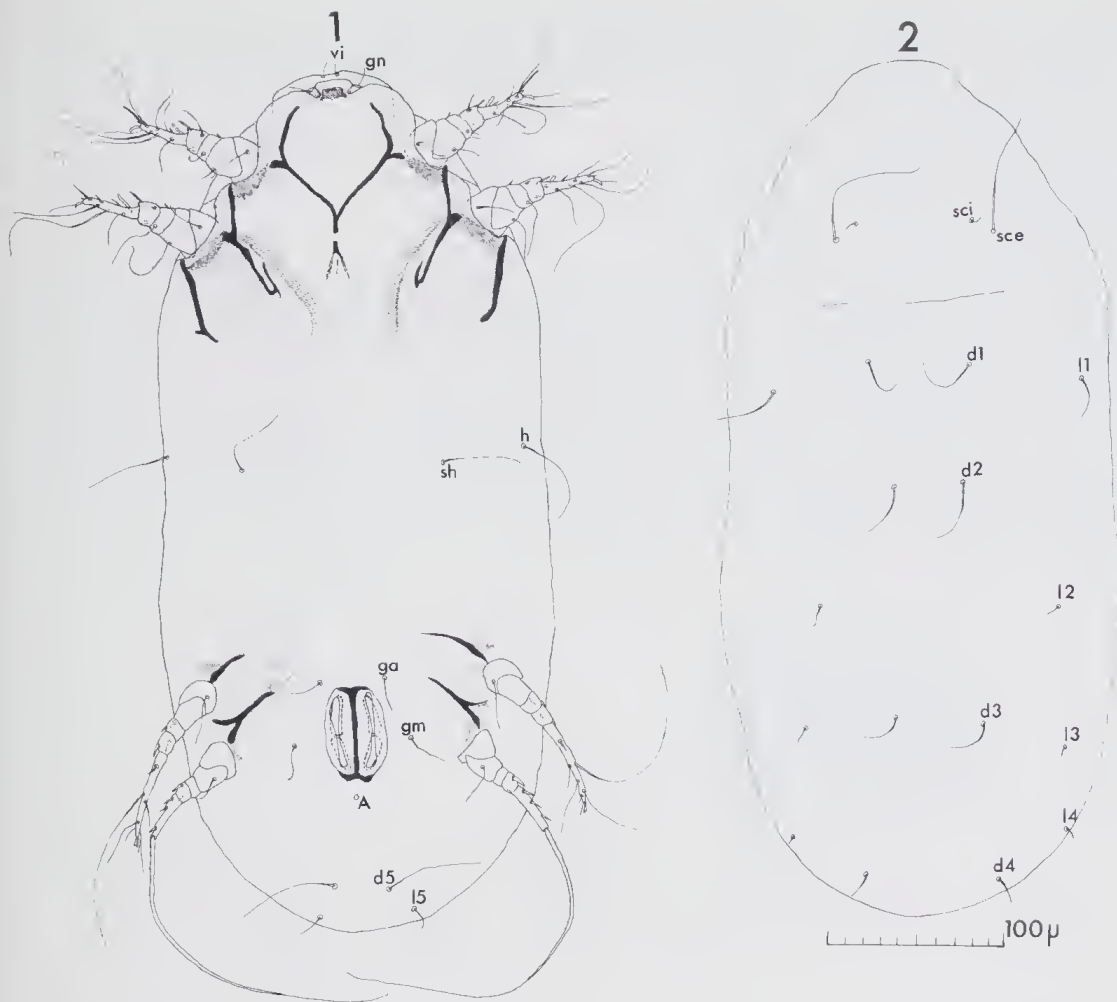
2 *Neottialges (Pelecanectes) grallinae* sp. nov.

With the characteristics of genus *Neottialges* Fain, 1966 and of subgenus *Pelecanectes* Fain, 1966. Known only from the hypopial stage. Hypopi of median size, white to pale yellow. Length holotype 499  $\mu$ , average 576  $\mu$  in 10 paratypes measured (437-665), width 219  $\mu$ , average in paratypes 243 (209-285).

Venter holotype (Fig. 1): Epimera I fused in Y-shape with bifid sternum, epimera II-IV free. Epimera and epimerite II of about same length. Formation of new epimera I and II in old hypopi distinct though feeble. Secondary sclerotization occurs in coxal fields II and III and partly in coxal region IV, and in some paratypes also between epimera I and the gnathosoma. Gnathosomatal shield with well marked anterior border. Gnathosomatal setae, 19  $\mu$ . Genital region with two pairs of parallel lying 20-23  $\mu$  long genital suckers and 52  $\mu$  long genital sclerite. Small anal pore (A) behind genital sclerite without sclerotized surrounding. Idiosomatal setae on ventral surface: *vi* (12  $\mu$ ), *sh* (49), *h* (51), *ga* (20), *gm* (20), *d 5* (71) and *l 5* (14).

Dorsum (Fig. 2): Cuticle in some paratypes in opisthosomatal part slightly sclerotized without distinct pattern. Sejugal furrow present only in median part. Setae of dorsum setiform and thin: *sci* (12), *sc e* (75), *d 1* (39), *d 2* (41), *d 3* (29), *d 4* (16), *l 1* (37), *l 2* (10), *l 3* (5), *l 4* (4).

<sup>1</sup> Dr R. Domrow, Brisbane, has since sent us 6 hypopi of this subspecies from 'breast muscle' of another new host, the white egret, *E. alba* (L.), Victoria, VIII.1977, J.H. Arundel. The smallest specimens (body length 800-900  $\mu$ ) are intermediate between Fig. 18-19 of Fain (1967), lacking epimera II, and with neoepimera II extending down midline one-half to two-thirds of distance to epimerites II. The largest specimen (body length 1300  $\mu$ ) is intermediate between Fig. 19-20, with neoepimera II touching on epimerites II, and with weak cross-bar between sternum and neoepimera II.



Figs 1-2: *Neottialges (Pelecanectes) grallinae* sp. nov., holotype venter (1) and dorsum (2).

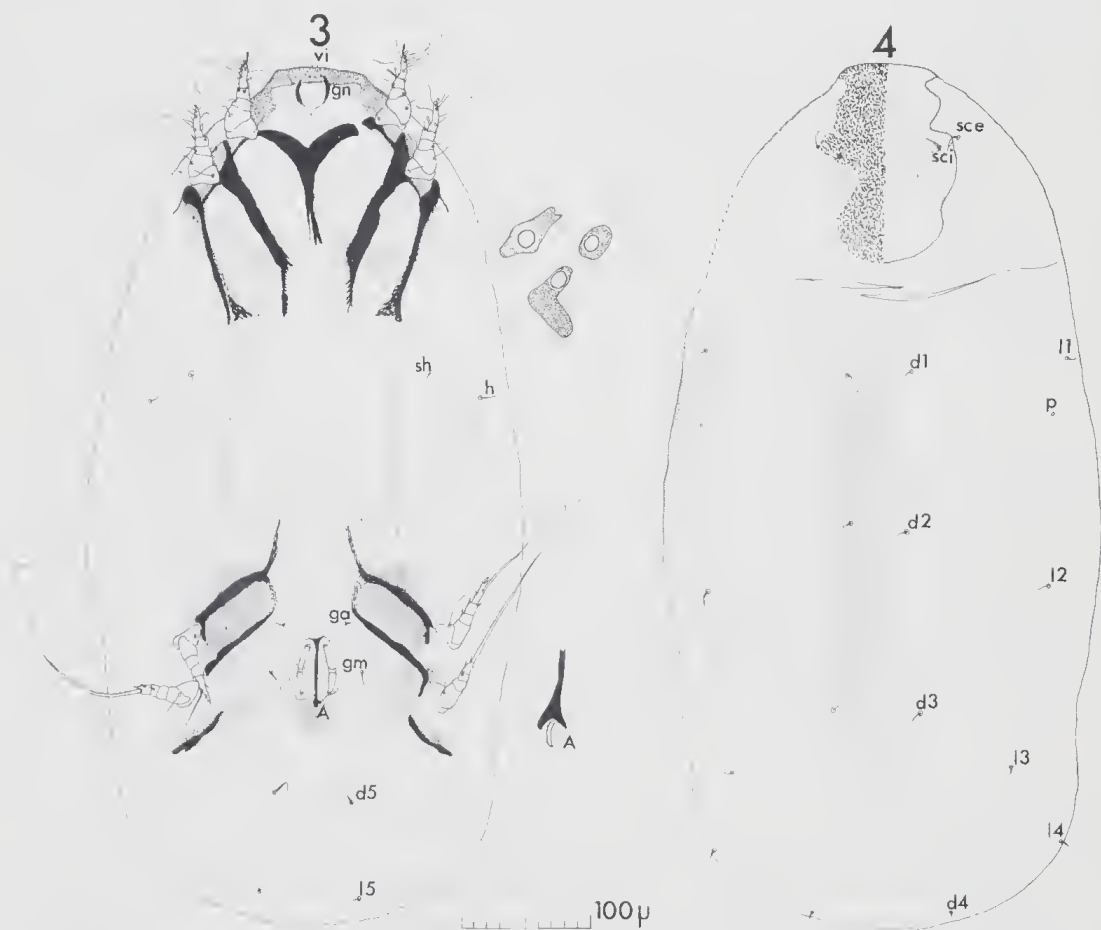
Legs (Figs 5-7): The five free segments without pretarsi and claws. All tarsi long (26, 29, 49, 32). Tarsi I and II with clawlike curved apical spine (8), tarsus III with 6  $\mu$  long bifid spine, tarsus IV with 181  $\mu$  long barbed strong seta. Chaetotaxy of legs: tarsi 10-10-9-4, tibiae 2-2-1-1, genua 2-2-1-0, femora 1-1-0-1, trochanters 1-1-1-0. Shape of setae as shown in the figures. Both setae on tibia II are spinelike (Fig. 5A). Solenidiotaxy: tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-1-0. *Omega* 1 10, *omega* 3 21, *omega* II 14, *phi* I-IV remarkable thin and tapering to end (14, 13, 10, 3).

Host and locality: *Grallina cyanoleuca* (Latham) (Grallinidae: Passeriformes), Napier Downs, 29 August 1976, Lukoschus leg.

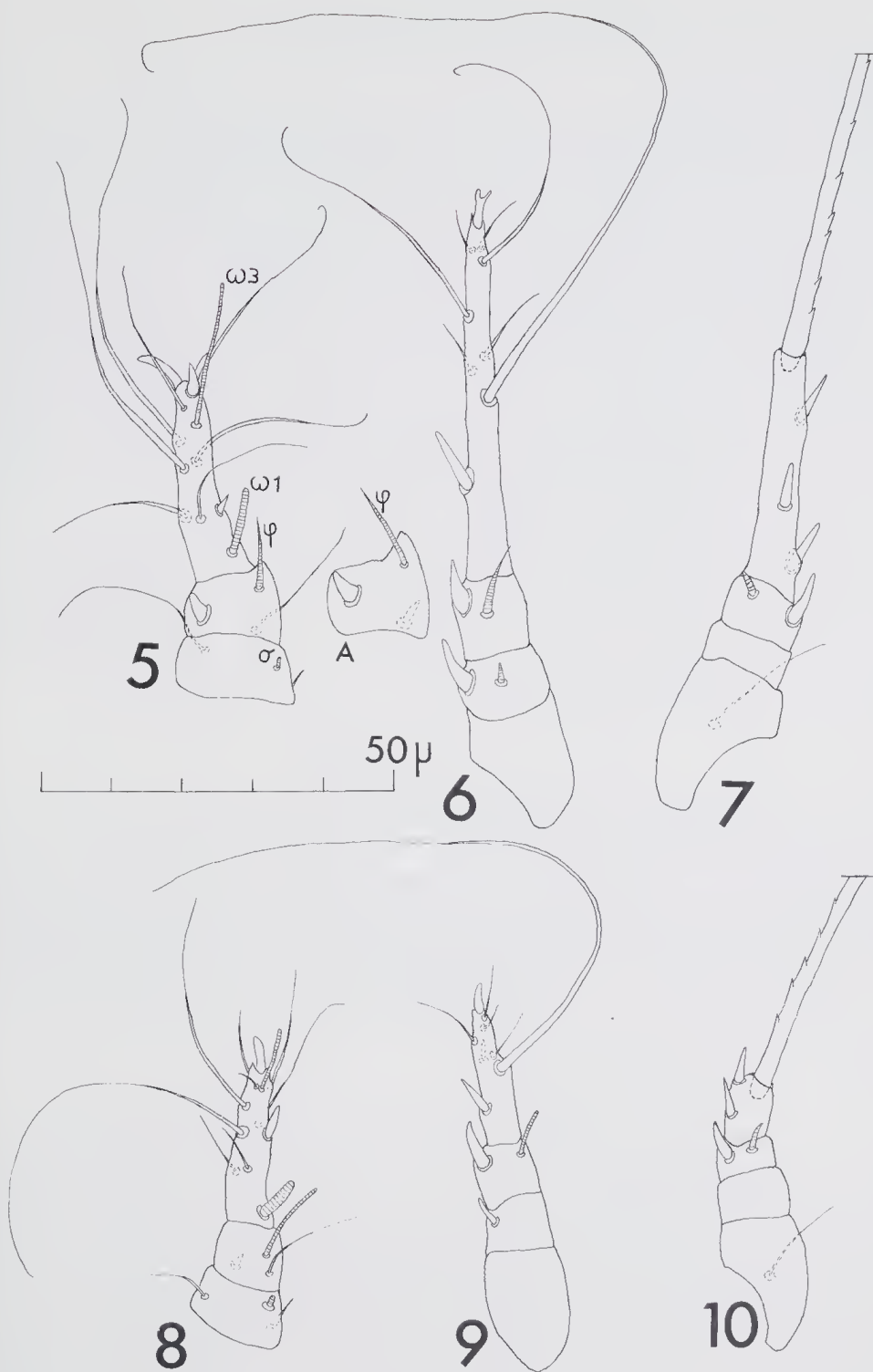
Deposition of types: Holotype in Western Australian Museum, Perth. Paratypes (50) in Perth; Field Museum of Natural History, Chicago; U.S.

National Museum of Natural History, Washington, D.C.; The Acarology Laboratory, Columbus, Ohio; British Museum (Natural History), London; Muséum National d'Histoire Naturelle, Paris; Institute of Parasitology, Prague; Zoologisches Museum Hamburg; Forschungsinstitut Senckenberg, Frankfurt; Bernice P. Bishop Museum, Honolulu; Institut de Médecine Tropicale Prince Léopold, Antwerp; Zoölogisch Laboratorium, Nijmegen.

Hypopi collected from *Podargus strigoides* do not fit the definitions of known genera because of a combination of characteristics, viz. all idiosomatal setae short, short tarsus IV with barbed seta, presence of genital sclerite with anal pore in bifurcate end of sclerite, lateral gnathosomatal sclerites not fused with epimera I, fairly strong sclerotization of median part of propodosoma, elongate internal sclerotizations beneath sternum and epimera II, and absence of *sigma* III. We erect the following new genus for the first species found in a caprimulgiform bird.



Figs 3-4: *Caprimuldectes podargi* gen. and sp. nov., holotype venter (3) and dorsum (4).



Figs 5-10: Legs I, III and IV of *Neottialges* (*Pelecanectes*) *grallinae* sp. nov. (5-7) and of *Caprimuldectes* *podargi* gen. and sp. nov. (8-10). A = tibia of leg II.



## CAPRIMULDECTES GEN. NOV.

### Definition

Median sized hypopi with relatively strong sclerotization. Forming of new epimerae in old hypopi not restricted to regions of epimera I and II and epimerite II, but also present in epimera III and epimerite IV. Lateral gnathosomatal sclerites fused in V-shape, not connected with epimera I. Idiosomatal setae short. Tarsus IV short, with two spines and long barbed seta. Apical spines of tarsi I-III simple, short and only slightly curved. Genital region with almost parallel lying genital suckers, genital sclerite and anal pore in posterior bifid end of sclerite. Punctated sclerotization median on propodosoma. Three internal sclerites present beneath sternum and epimera II. *Sigma* III absent. Chaetotaxy: tarsi 10-10-8-3, tibiae 2-2-1-1, genua 2-2-1-0, femora 1-1-0-1, trochanters 1-1-1-0. Solenidiotaxy: tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-0-0.

Type species: *Caprimuldectes podargi* sp. nov.

The genus is related to *Tytodectes* Fain, 1966. Main differences are: absence of basically flattened setae on tarsi I-III, apical spines on legs I and II one-pointed and gnathosomatal sclerites fused in V-shape.

### CAPRIMULDECTES PODARGI SP. NOV.

Hypopus (holotype) of long-ovoid shape of medium size with white to pale yellow colour with yellow legs, and brown epimera, epimerites and anterior part of dorsum. With the characteristics of the genus mentioned above. Length 675  $\mu$ , average 687  $\mu$ , in 10 paratypes measured (589-760), width 303  $\mu$ , average in paratypes 352 (285-380).

Venter (Fig. 3): Cranial part blunt and strongly sclerotized. Epimera I fused in broad Y-shape, epimera II-IV free. Epimera and epimerite II of same length. Secondary prolongations of epimera I-III and epimerites II and IV. Coxal fields I-IV more punctated and sclerotized than other parts of venter. Lateral gnathosomatal sclerites (gn) fused in broad V-shape without connection to epimera I. Gnathosomatal setae (11) lateral to those sclerites. Internal sclerites with central hollow of dumb-bell shape beneath sternum and epimera II. Genital region with 55  $\mu$  long genital sclerite, bifid on both sides, two pairs of genital suckers (17-20) lying almost parallel, and anal pore in posterior bifurcation of sclerite. Idiosomatal setae on venter: *vi* (2), *sh* (16), *h* (11), *ga* (13), *gm* (13), *d* 5 (15) and *l* 5 (5).

Dorsum (Fig. 4): Median part of propodosoma densely punctured and relatively strongly sclerotized. Sejugal furrow in transverse band of soft cuticle. Histerosoma with punctured median part with typical pattern in front of *d* 2 and less sclerotized and punctured sides. Dorsal setae short: *sc i* (6), *sc e* (12), *d* 1-4 (4-5), *ℓ* 1 (7), *ℓ* 2 (7), *ℓ* 3 (6), *ℓ* 4 (4).

Legs (Figs 8-10) with the five free segments without pretarsi and claws. Tarsi I-III with short (4-5) simple, slightly bent spine, tarsus IV with 159  $\mu$  long barbed strong seta. Tarsi I-IV 18, 23, 20, 10  $\mu$  long. Chaetotaxy and solenidiotaxy as defined for genus. 102  $\mu$  long seta based in median part of tarsus III. Solenidia *omega* 1 (7), *omega* 3 (11), *omega* II (7), *phi* I-IV (11, 11, 6, 3), *sigma* I and II (2, 2).

Host and locality: *Podargus strigoides* (Latham) (Caprimulgidae: Caprimulgiformes), Beagle Bay, 24 August 1976, Lukoschus leg.

Deposition of types: Holotype in WAM, Perth. Paratypes (52) in Perth, Chicago, Washington, Columbus, London, Paris, Prague, Hamburg, Frankfurt, Antwerp, Nijmegen.

## ACKNOWLEDGEMENTS

This paper results from the combined Western Australia Field Programme 1976-1977 between the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of William S. and Janice Street, Ono, Washington, and the aid of grant R87-111 by the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

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## PARASITES OF WESTERN AUSTRALIA

### II

## NASAL MITES FROM BIRDS (ACARINA: RHINONYSSIDAE, DERMANYSSIDAE, EREYNETIDAE AND CYTODITIDAE)

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and

F.S. LUKOSCHUS†

[Received 26 May 1977. Accepted 16 November 1977. Published 26 February 1979.]

### ABSTRACT

Fifteen species of nasal mites (Acarina) from birds are reported from Western Australia. Amongst them 6 species are new and are described.

### INTRODUCTION

Nasal mites from birds have been extensively studied in Australia by Domrow (1969). All these investigations were made in Eastern Australia, especially in Queensland. The western regions of Australia have apparently not been explored.

During the Kimberley expedition in Western Australia in 1976, one of us (F.S.L.) collected nasal mites belonging to 15 different species. Amongst these species 6 are new and are described herein.

The width of the body utilized here is the maximum width. The abbreviations utilized in the descriptions of Mesostigmata are those proposed by Fain & Hyland (1962).

The types of the new species are deposited in the Western Australian Museum, Perth. Paratypes are in the Field Museum of Natural History, Chicago, U.S.A. and in the collection of authors.

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## ORDER MESOSTIGMATA

FAMILY RHINONYSSIDAE TROUESSART, 1895  
GENUS *PTILONYSSUS* BERLESE & TROUESSART, 1889

### *PTILONYSSUS GLICIPHILAE* DOMROW, 1966

The typical host of this species is *Lichmera indistincta* (Vigors & Horsfield) (Meliphagidae, Passeriformes), from Queensland. Our specimens were found in the same host from four localities, in W. Australia: Beagle Bay, 21 to 24.VIII.1976 (18 females, 3 nymphs); Beverley Springs, 23.IX.1976 (18 females and 7 nymphs); Brooking Springs, 7.X.1976 (12 females, 5 nymphs); Mitchell Plateau, 17.X.1976 (5 females).

### *PTILONYSSUS EMBERIZAE* FAIN, 1956

This species was described from *Emberiza flaviventris* Stephens, in Rwanda. Domrow recorded this species from *Hirundo rustica* Linnaeus and *Erythrura gouldiae* (Gould) in Queensland. Our specimens were found in *Poephila bichenovii* (Vigors & Horsfield), Mount Hart, W. Australia, 13.IX.1976 (2 females), which is a new host record.

### *PTILONYSSUS ASTRIDAE* FAIN, 1956

This species was described from *Lagonosticta rubricata congica* Sharpe (Ploceidae, Estrildinae, Passeriformes), Rwanda.

We have found it in the nares of *Lonchura castaneothorax* (Gould), from Mount Hart, W. Australia, 13.IX.1976 (15 females, 5 males and 7 nymphs and 1 larva). This is a new host record.

### *PTILONYSSUS CRACTICI* DOMROW, 1964

This species was known from various Cracticidae (Passeriformes) in Queensland, including *Cracticus nigrogularis* (Gould). Our specimens were found in this host from Beagle Bay, W. Australia, 26.VIII.1976 (3 females).

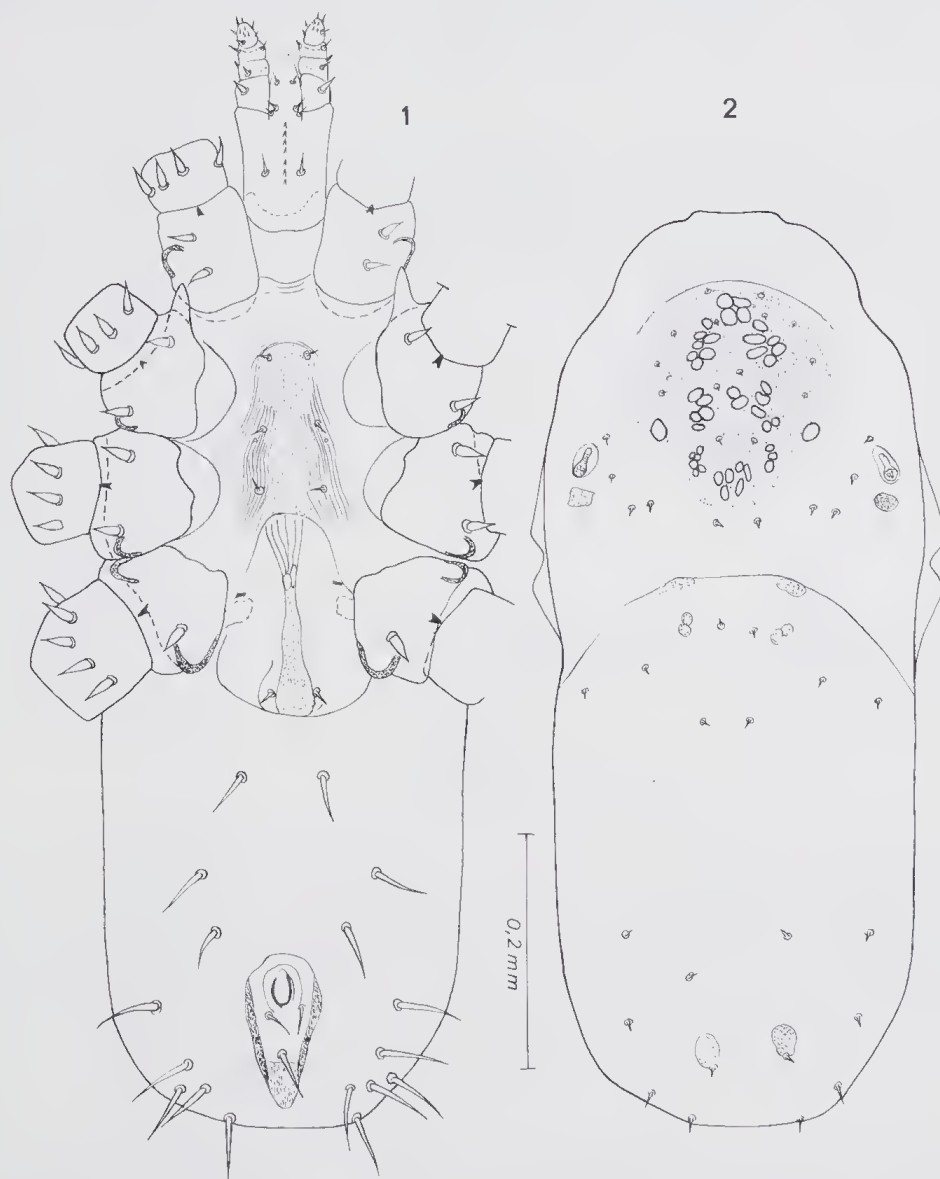
### *PTILONYSSUS GRALLINAE* DOMROW, 1964

This species was described from *Grallina cyanoleuca* (Latham), in Queensland. Our specimens were found in the nares of the typical host in Napier Range, W. Australia, 29.VIII.1976 (29 females and 6 nymphs).

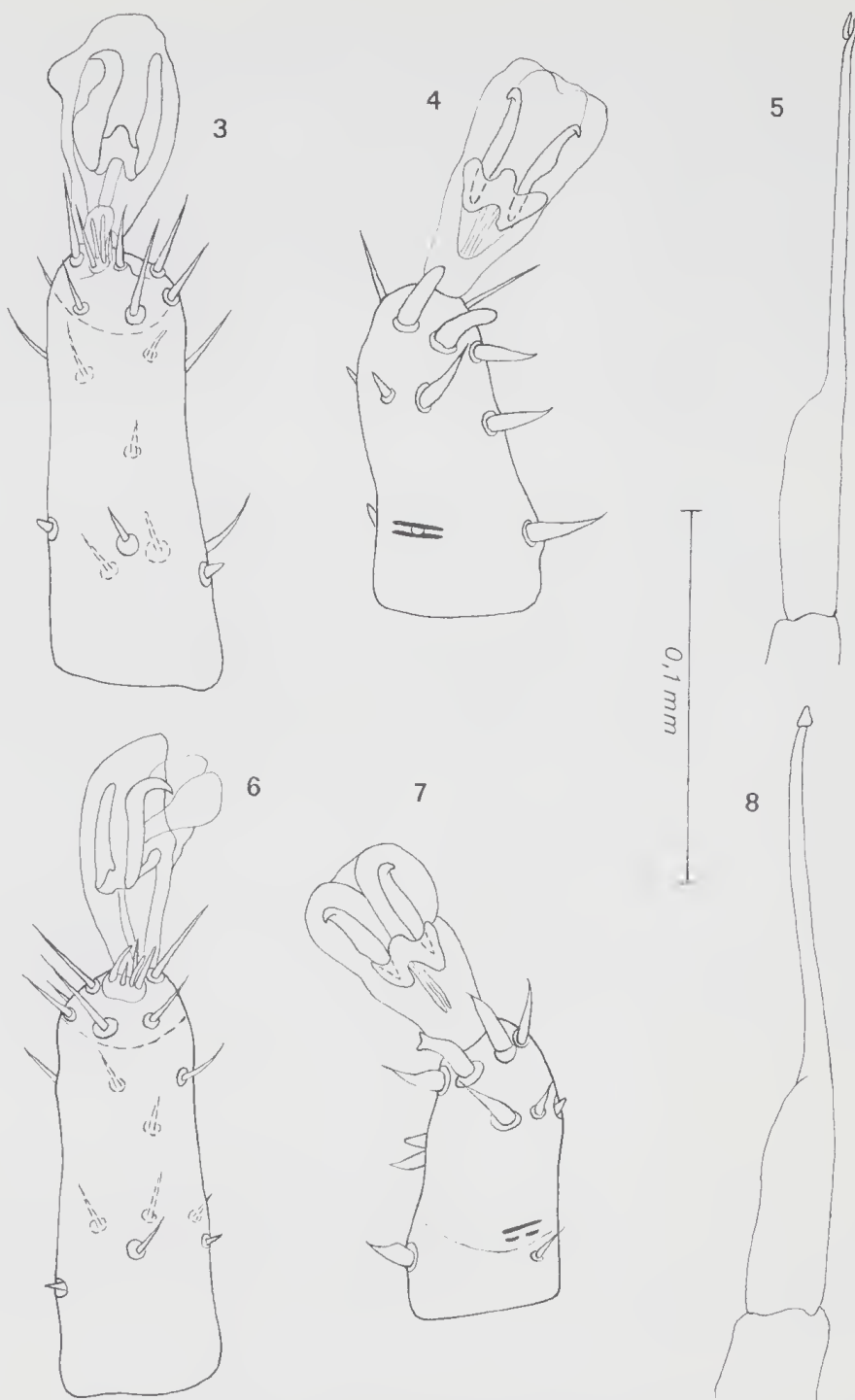
*PTILONYSSUS CONDYLOCOXA* SP. NOV.

This species is well characterized by the presence on coxae I-IV of rounded ventral anterior or posterior processes.

Female (holotype) (Figs 1-5): LId 690  $\mu$ ; WId 270  $\mu$ ; LPP 180  $\mu$ ; WPP 180  $\mu$ ; LSP 120  $\mu$ ; WSP 45  $\mu$ ; LGP 156  $\mu$ ; WGP 30  $\mu$ ; LAP 126  $\mu$ ; WAP 63  $\mu$ ; LG 186  $\mu$ ; WG 84  $\mu$ ; LP 80  $\mu$ ; LCH 170  $\mu$ . Length of cheliceral bulb 60  $\mu$ . width of cheliceral bulb 18  $\mu$ .



Figs 1-2: *Ptilonyssus condylocoxa* sp. nov. Female. Fig. 1 — Venter. Fig. 2 — Dorsum.



Figs 3-8: Figs 3-5: *Ptilonyssus condylocoxa* sp. nov. Female. Fig. 3 — Tarsus I. Fig. 4 — Tarsus IV. Fig. 5 — Chelicera.  
 Figs 6-8: *Ptilonyssus conopophilae* sp. nov. Female. Fig. 6 — Tarsus I. Fig. 7 — Tarsus IV. Fig. 8 — Chelicera.

Dorsum: Prodosomal plate rounded anteriorly, abruptly narrowed posteriorly, bearing 7 pairs of very small setae. Small punctate plate behind spiracle. All setae of podosoma very small. Opisthonotum bearing small spines, anterior region slightly produced into two lobes. Two small paramedian pygidial shields, each carrying a short spine.

Venter: Sternal shield poorly sclerotized, irregular in shape. Genital shield narrow, with the two genital setae near its posterior extremity. Opisthogaster bearing in its posterior half 7 pairs of strong setae  $45\ \mu$  long. Anterior anal setae situated at the level of posterior border of anus and much smaller than the third anal seta. Gnathosoma: palps slightly shorter than the gnathosomal base.

Legs: Coxae I-IV with unequal rounded ventral projections or lobes; on coxa I there is a rounded poorly distinct posteroventral projection; on coxa II there is a strong anterior triangular lobe and a less distinct rounded posterior projection; coxa III with two small rounded lobes, one anterior and one posterior; coxa IV as on coxa III but with larger lobes. All coxae and trochanters with ventral conical spines 6 to  $9\ \mu$  wide, ending in a short filament. Anterior setae of legs III-IV are short spines. Tarsi II-IV with two apicoventral thick spines, the anterior truncate, the posterior pointed.

Male: The only male specimen is in the moulting stage and still enclosed in its nymphal skin. It is therefore difficult to study.

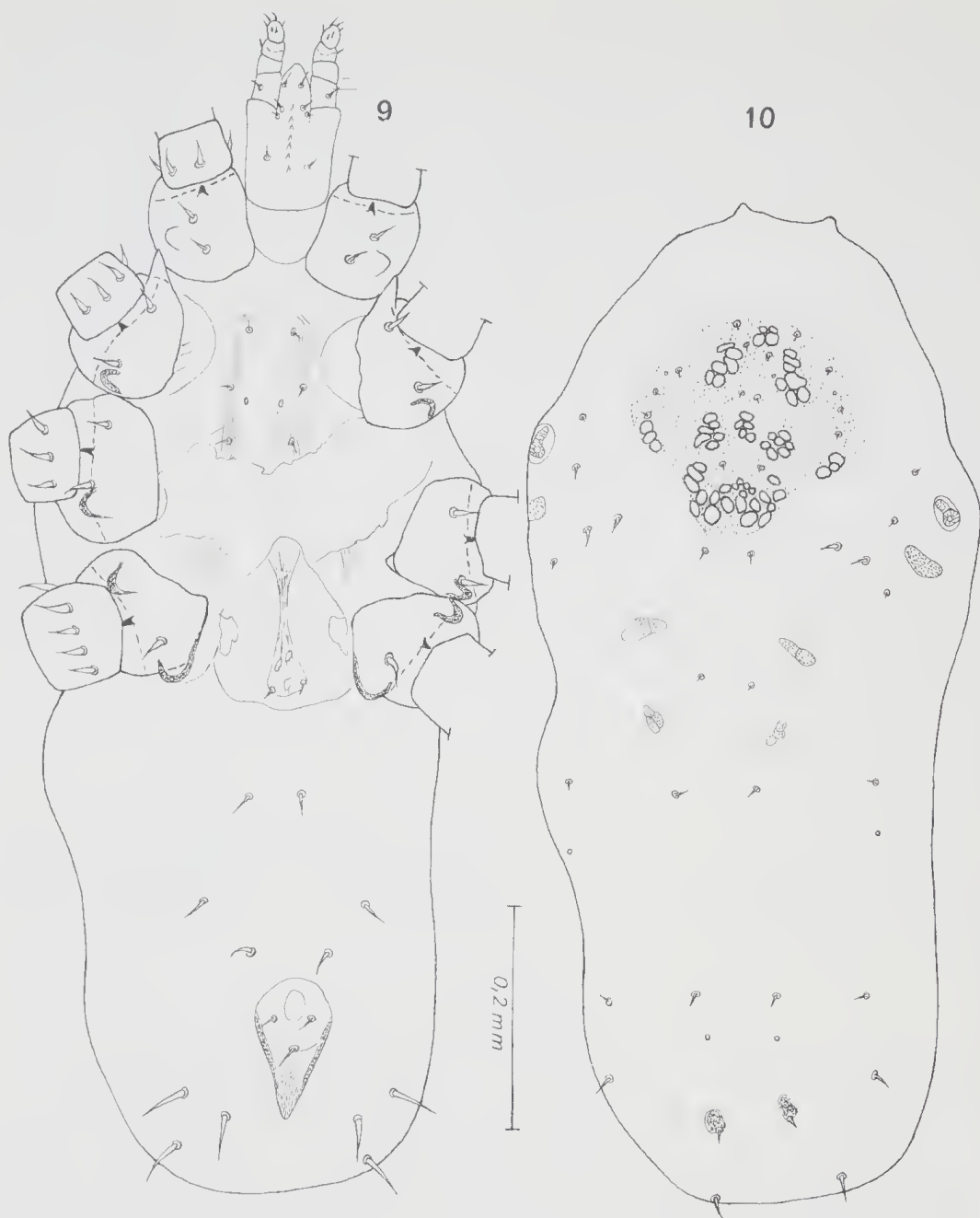
### Host and Locality

In the nares of *Ramsayornis fasciatus* (Gould), Beverley Springs, 23.IX.1976. Holotype and 9 female paratypes, one male in moulting stage and three nymphs.

### *PTILONYSSUS CONOPOPHILAE* SP. NOV.

This species, as in *P. condylocoxa*, with a rounded projection on the ventral surface of the coxae II to IV. It is distinguished from that species by the following characters: greater size of 2 pairs of setae situated close to the posterolateral corners of the prodosomal shield, prodosomal shield wider than long; differently shaped coxal and tarsal setae; smaller number and size of posteroventral setae of opisthosoma; different shape of apicoventral spines of tarsi II-IV; very poor development of sternal shield; smaller length of genital plate.

Female (holotype) (Figs 6-10): LId  $840\ \mu$ ; WId  $390\ \mu$ ; LPP  $190\ \mu$ ; WPP  $210\ \mu$ ; LGP  $135\ \mu$ ; WGP  $32\ \mu$ ; LAP  $120\ \mu$ ; WAP  $66\ \mu$ ; LG  $162\ \mu$ ; WG  $84\ \mu$ ; LP  $75\ \mu$ ; LCH  $175\ \mu$ . Cheliceral bulb: length  $63\ \mu$ , width  $18\ \mu$ .



Figs 9-10: *Ptilonyssus conopophilae* sp. nov. Female. Fig. 9 — Venter. Fig. 10 — Dorsum.

Dorsum: Podosomal plate rounded anteriorly, abruptly narrowed posteriorly, bearing 7 pairs of very small setae. The two setae situated on cuticle at both sides of podosomal shield, at its posterior level, are spinous



and larger than the other podosomal setae. A small punctate plate behind spiracles; two very small paramedian pygidial shields each with a short spine.

Venter: Sternal area very poorly sclerotized. Genital shield narrow, widening in posterior part where it bears the two genital setae. Anterior anal setae situated at level of the posterior border of anus. Gnathosoma relatively small.

Legs: Coxa II with a strong antero-ventral triangularly sclerotized process and a posteroventral rounded and shorter process; coxa IV with two ventral rounded processes, a small anterior and a large posterior; coxa III with similar but smaller processes. Setae of coxae I-IV inflated basally and strongly narrowed apically. Anterior surfaces of legs III-IV with triangular spines. Tarsi II-IV with two apicoventral asymmetrical spines, an anterior bifid and a posterior very finely attenuated apically.

Male: unknown.

#### Host and Locality

Holotype female from *Conopophila picta* (Meliphagidae, Passeriformes), Napier Downs, 3.IX.1976.

Three female paratypes from *Conopophila rufogularis* (Gould), Brooking Springs, 1.X.1976.

One female paratype from *Poephila guttata* (Vieillot), Brooking Springs, 2.X.1976. This might be an accidental host for this species.

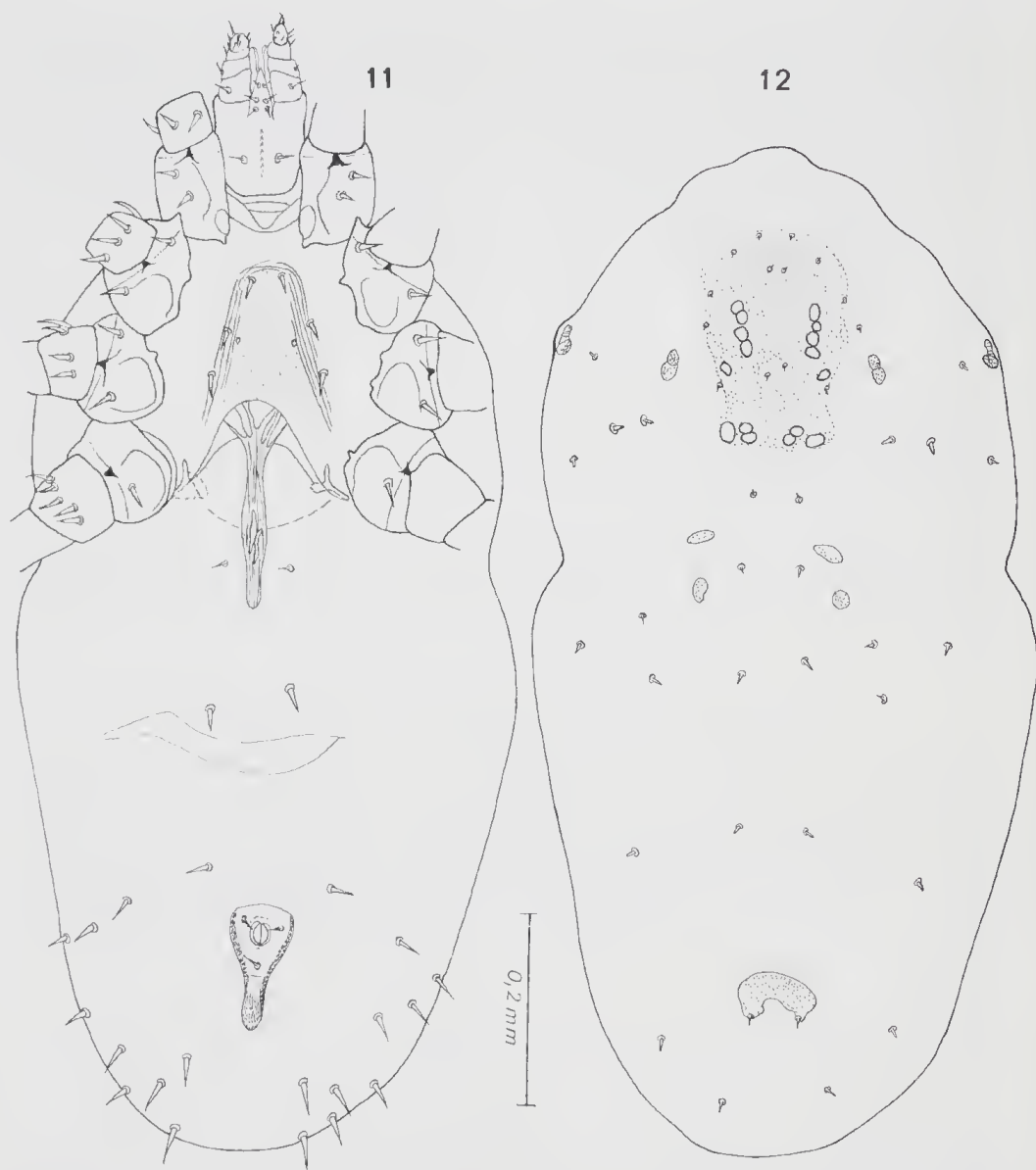
#### *PTILONYSSUS PSEUDOTHYMANZAE* SP. NOV.

This species is distinguished from *Ptilonyssus thymanzae* Domrow (1964) mainly by the following characters: presence at both sides of posterior corners of propodosomal shield of two pair of setae much stronger than the other dorsal setae; different shape of the podosomal shield which is wider in its posterior half and bears more setae; greater number of opisthogastral setae; cheliceral bulb relatively shorter compared to total length of chelicerae.

Female (holotype) (Figs 11-15): Lld 1038  $\mu$ ; Wld 460  $\mu$ ; LPP 210  $\mu$ ; WPP 150  $\mu$ ; LpP 45  $\mu$ ; WpP 75  $\mu$ ; LGP 200  $\mu$ ; WGP 21  $\mu$ ; LAP 123  $\mu$ ; WAP 66  $\mu$ ; LG 192  $\mu$ ; WG 90  $\mu$ ; LP 86  $\mu$ ; LCH 210  $\mu$ . Length of cheliceral bulb 70  $\mu$ ; width of cheliceral bulb 21  $\mu$ . Podosomal plate distinctly narrowed in posterior half and bearing 6 pairs of small setae. At each side of the shield a small accessory shield longer than wide. At both sides of posterior corners of median shield 2 pairs of spines, 12  $\mu$  long with a blunt apex. Opisthosoma

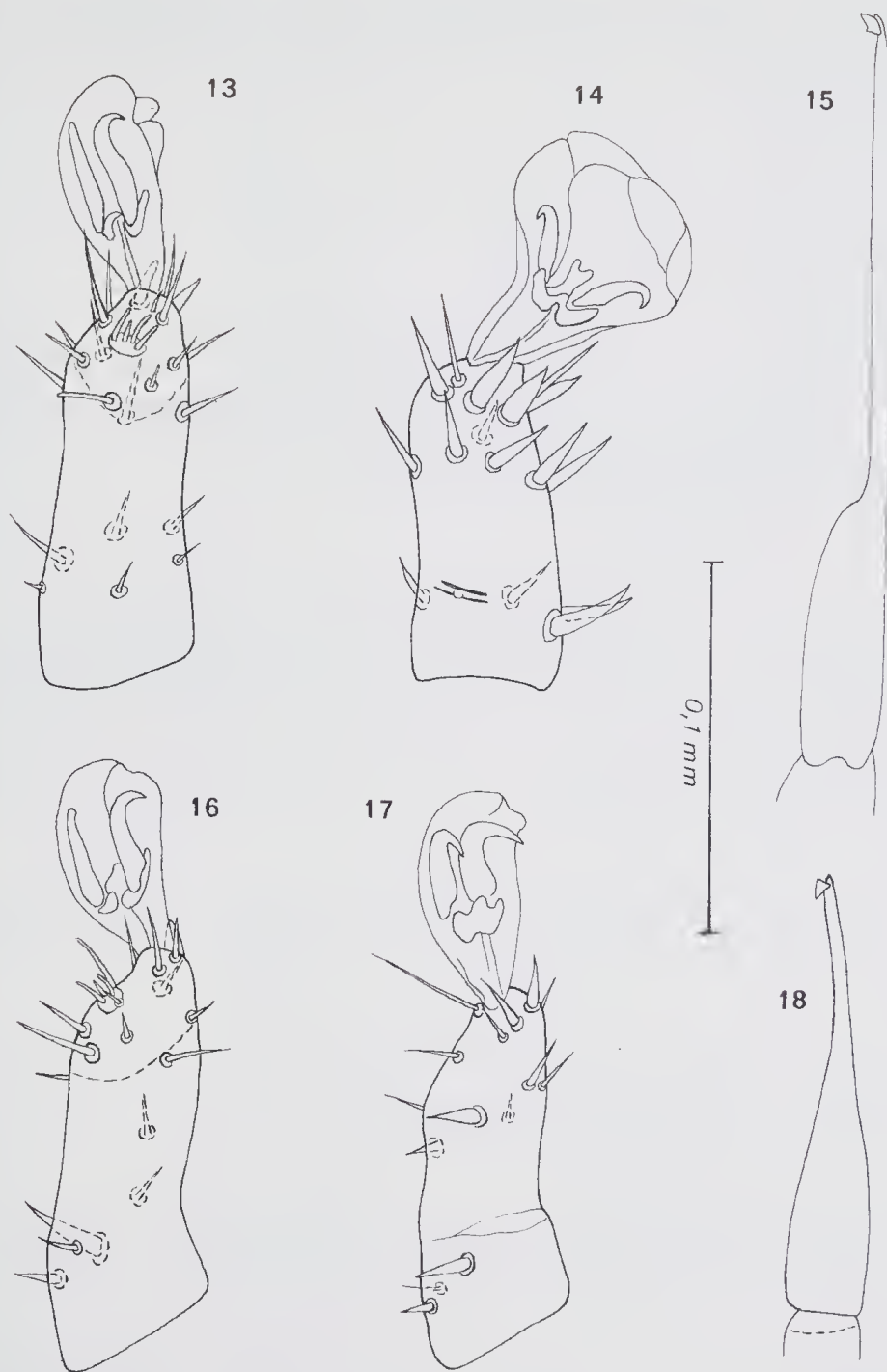
bearing short setae with rounded apices except the posterolateral setae which are longer and pointed.

Venter: Sternal shield punctate, the two posterior pairs of sternal setae situated on the soft cuticle. Opisthosomal setae conical, strong. Anterior anal setae at level of anterior border of anus.



Figs 11-12: *Ptilonyssus conopophilae* sp. nov. Female. Fig. 11 — Venter. Fig. 12 — Dorsum.





Figs 13-18: Fig. 13-15 — *Ptilonyssus pseudothymanzae* sp. nov. Female. Fig. 13 — Tarsus I. Fig. 14 — Tarsus IV. Fig. 15 — Chelicera.  
 Figs 16-18 — *Ptilonyssus pentagonicus* sp. nov. Female. Fig. 16 — Tarsus I. Fig. 17 — Tarsus IV. Fig. 18 — Chelicera.

Legs: Coxa II with a small triangular anterior process. Coxae I to IV with spines; the anterior setae of legs III-IV are strong spines.

Male: unknown.

#### Host and Locality

Holotype and 4 female paratypes in the nares of *Meliphaga flavescens* (Gould), Beverley Springs, 17.IX.1976.

We attribute provisionally to *P. pseudothymanzae* 3 specimens (2 females and 1 larva) which differ from this species by the following characters: setae of legs and gnathosoma distinctly smaller, podosomal shield narrower. These specimens were collected in the nares of *Melithreptus albogularis* Gould, Mitchell Plateau, W. Australia, 17.X.1976.

#### *PTILONYSSUS PENTAGONICUS* SP. NOV.

This species is characterized by the shape of the podosomal shield roughly pentagonal, the shape of cheliceral bulbs progressively attenuated anteriorly and the chaetotaxy of the tarsi II-IV bearing several thin setae. It is distinguished from *P. myzanthae* Domrow (1964) by the pentagonal shape of the podosomal shield, the rectangular shape of the gnathosomal base, and the presence of a median pygidial plate.

Female (Figs 16-20): LI<sub>d</sub> 555  $\mu$ ; WI<sub>d</sub> 345  $\mu$ ; LPP 170  $\mu$ ; WPP 169  $\mu$ ; LpP 40  $\mu$ ; WpP 68  $\mu$ ; LGP 100  $\mu$ ; WGP 12  $\mu$ ; LAP 106  $\mu$ ; WAP 45  $\mu$ ; LG 135  $\mu$ ; WG 78  $\mu$ ; LP 60  $\mu$ ; LCH 123  $\mu$ . Cheliceral bulb length 60  $\mu$ , width 16-18  $\mu$ .

Dorsum: Podosomal plate roughly pentagonal, bearing 7 pairs of short setae. Spiracle without posterior shield. All podosomal and opisthosomal setae very short. Pygidial plate wider than long.

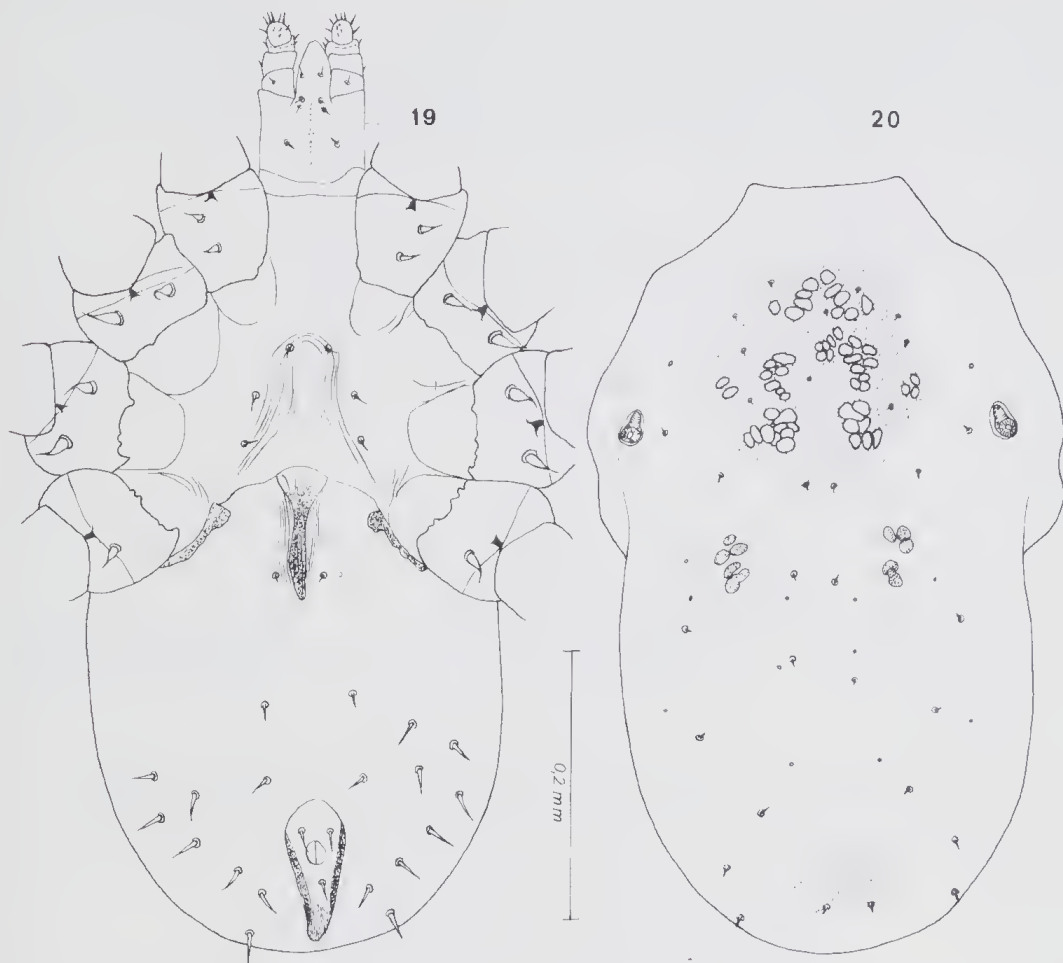
Venter: Sternal shield narrow, poorly sclerotized. Genital setae off the genital shield. Anal shield with anterior setae far in front of anus. Posterior setae strong, 15-25  $\mu$  long. Gnathosoma: Cheliceral bulb progressively attenuated anteriorly, gnathosomal base rectangular, bearing a pair of very short and thin setae.

Legs: Coxal setae ovoid, very thick, presenting a very thin prolongation. Claws strong.

Male: unknown.

## Host and Locality

Holotype and 5 female paratypes from *Manorina flavigula* (Gould), Mount Hart, 10.IX.1976.



Figs 19-20: *Ptilonyssus pentagonicus* sp. nov. Female. Fig. 19 — Venter. Fig. 20 — Dorsum.

## GENUS *STERNOSTOMA* BERLESE & TROUESSART, 1889

### *STERNOSTOMA GLICIPHILAE* DOMROW, 1966

This species is known only from female specimens found in *Lichmera indistincta* (Vigors & Horsfield), in Queensland.

We have found in *Ramsayornis fasciatus* (Gould) at Beverley Springs, 23.IX.1976, a male that we attribute to this species. This specimen bears

two dorsal shields, a podosomal very large and an opisthosomal rectangular and longer than wide. These two shields present a well-marked network pattern similar to that in the female described by Domrow. The same network is visible in the small sternal and genital shields. Tarsi II-IV with 7 narrow cylindrical ventral setae. In the female of *S. gliciphilae* these setae are shorter and not cylindrical. Gnathosoma as in the female but with base shorter. It is possible that this male represents a new species. We prefer to regard it provisionally as *S. gliciphilae* until new material becomes available.

GENUS *MESONYSSOIDES* FAIN & NADCHATRAM, 1962

*MESONYSSOIDES APROSMICTI* DOMROW, 1964

This species has been described from the nares of *Aprosmictus erythrop-terus* (Gmelin) (Psittacidae), Queensland. Our specimens were collected in the same host from Napier Downs, W. Australia, 3.IX.1976 (8 females, 2 males, 1 nymph and 1 larva).

GENUS *MESONYSSUS* FAIN, 1960

*MESONYSSUS GEOPELIAE* FAIN, 1964

This species has been described from *Geopelia striata striata* (Linnaeus), from Malaya.

Domrow (1969) found it in Queensland, in three new hosts: *Geopelia striata placida* Gould, *G. humeralis* (Temmink) and *G. cuneata* (Latham).

We collected one female specimen from *Geopelia striata placida* at Port Warrender, 31.X.1976.

FAMILY *DERMANYSSIDAE* KOLENATI, 1859

GENUS *HATTENA* DOMROW, 1963

*HATTENA PANOPLA* DOMROW, 1966

The unusual genus *Hattena* has been created by Domrow to accommodate a new species *H. erosa* Domrow, 1963 found on a bird from Mt Kinabalu, Borneo.

In 1966, Domrow described a second species in this genus, *H. panopla* from the nasal cavities of *Lichmera indistincta* (Vigors & Horsfield), from Australia.

The systematic position of this specialized genus is difficult to ascertain. Domrow (1963) placed *H. erosa* in or close to the Dermanyssidae. Later, Domrow (1966) in describing *H. panopla* noted 'it is a little difficult to decide if this specimen is a blattisociine or a platyseine'.

We place this genus provisionally in the Dermanyssidae; however, it does not correspond exactly with the definitions for the different subfamilies composing this family as given by Evans & Till (1966).

*Hattena panopla* was only known from the holotype female. We have found in the typical host, at Beagle Bay (21 and 23.VIII.1976), 4 female specimens, 3 males and one nymph belonging to this species. This mite is probably not a true parasite, but merely a flower mite transported phoretically by birds. We give below a description of the male.

Male: Idiosoma 540  $\mu$  long and 360  $\mu$  wide. Dorsal shield larger than in female bearing 26 pairs of setae and without lateral incisions. Sternigenital shield widely separated from ventrianal shield; the latter rounded and bearing one pair of ventral setae plus the 3 anal setae. Coxae II and III with one and two strong spines respectively. A strong spine present on ventral surface of tibia, genu and femur of legs II and III. Rows of denticles are present on apical margins of most of the leg segments. They are particularly developed on coxae II. Gnathosoma: as in female. A short *pilus dentilis* is present. Spermatodactyl 45  $\mu$  long, relatively narrow.

## ORDER PROSTIGMATA

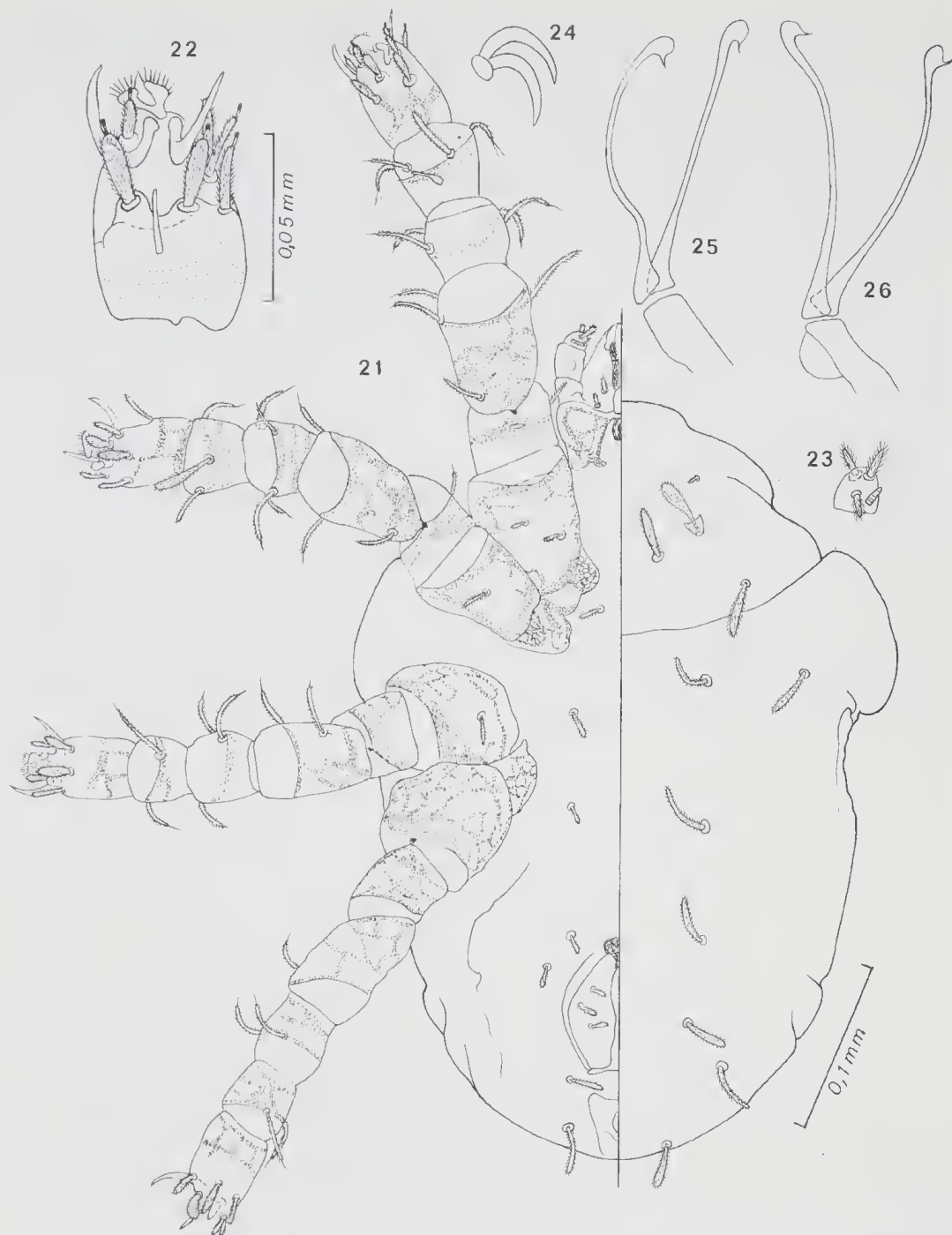
FAMILY EREYNETIDAE OUDEMANS, 1931

GENUS *BOYDAIA* WOMERSLEY, 1953

*BOYDAIA* (*BOYDAIA*) *PODARGI* SP. NOV.

This species belongs to the 'spatulata' group (see Fain 1971). The coxae bear 2-1-1-0 setae, the femora I and IV bear 7 and 2 setae respectively. This combination of characters exists in 3 species: *B. spatulata* Fain, *B. mimi* Fain & Hyland and *B. saxicolae* Fain. This species is however distinguished from the latter, in the female by the shape of the sensillae which are strongly inflated and by the great length of most of the body and leg setae; in the larva by the different shape of the claws.

Female (Figs 21-23): Holotype 480  $\mu$  long, including gnathosoma and 315  $\mu$  wide.



Figs 21-26: *Boydaia podargi* sp. nov. Fig. 21-23 — Female. Fig. 21 — Female in ventral (left) and dorsal (right) view. Fig. 22 — Tarsus I of leg. Fig. 23 — Tarsus of palp. Fig. 24-26 — Claws of larva. Fig. 24 — Leg I. Fig. 25 — Leg II. Fig. 26 — Leg III.



Dorsum: Sensillae inflated, club-shaped,  $33\ \mu$  long and  $9\ \mu$  wide. All dorsal setae finely barbed, very slightly spindle-shaped, 27 to  $36\ \mu$  long, except the *ve* which is very short.

Venter: There are 3 pairs of *ic* setae, 5 pairs of *g* setae (3 pairs of *gm* and 2 pairs of *ge*) and 2 pairs of anal setae (for the nomenclature of these setae, see Fain 1970). Vulvar slit  $105\ \mu$  long. Legs with a well-developed network pattern and bearing long barbed setae. The setae of femur I are 18 to  $39\ \mu$  long. The ventral setae of tibiae I-IV are  $35\text{--}38\ \mu$  long. Pulvilli as in *Boydaia spatulata*. Chaetotaxy of legs (I-IV): Coxae 2-1-1-0. Trochanters 1-1-0-0. Femora 7-4-3-2. Genua 4-4-3-3. Tibiae 5-3-2-3. Tarsi 12-8-7-7. Gnathosoma with two pairs of setae. Palps with three segments, the apical segment bears 3 barbed setae and a solenidion.

Male: unknown.

Larva (Figs 24-26): We have only a larval skin. Leg I with normal and small claws. Legs II-III with two long and narrow modified claws with a small recurved hook-like apex.

#### Host and Locality

Holotype and 8 female paratypes and one larval skin, from the nares of *Podargus strigoides* (Latham), Beagle Bay, 24.VIII.1976.

### ORDER ASTIGMATA

#### FAMILY CYTODITIDAE OUDEMANS, 1908

#### GENUS *CYTODITES* MEGNIN, 1877

#### *CYTODITES GEOPELIAE* SP. NOV.

This species is distinguished from the other species in the genus in both sexes by the very great size of the gnathosoma and the structure of the membranous ambulacra.

Female (Figs 27-30): Holotype  $470\ \mu$  long (gnathosoma included) and  $315\ \mu$  wide (maximum width). In two paratypes these measurements are  $460 \times 315\ \mu$  and  $465 \times 330\ \mu$ .

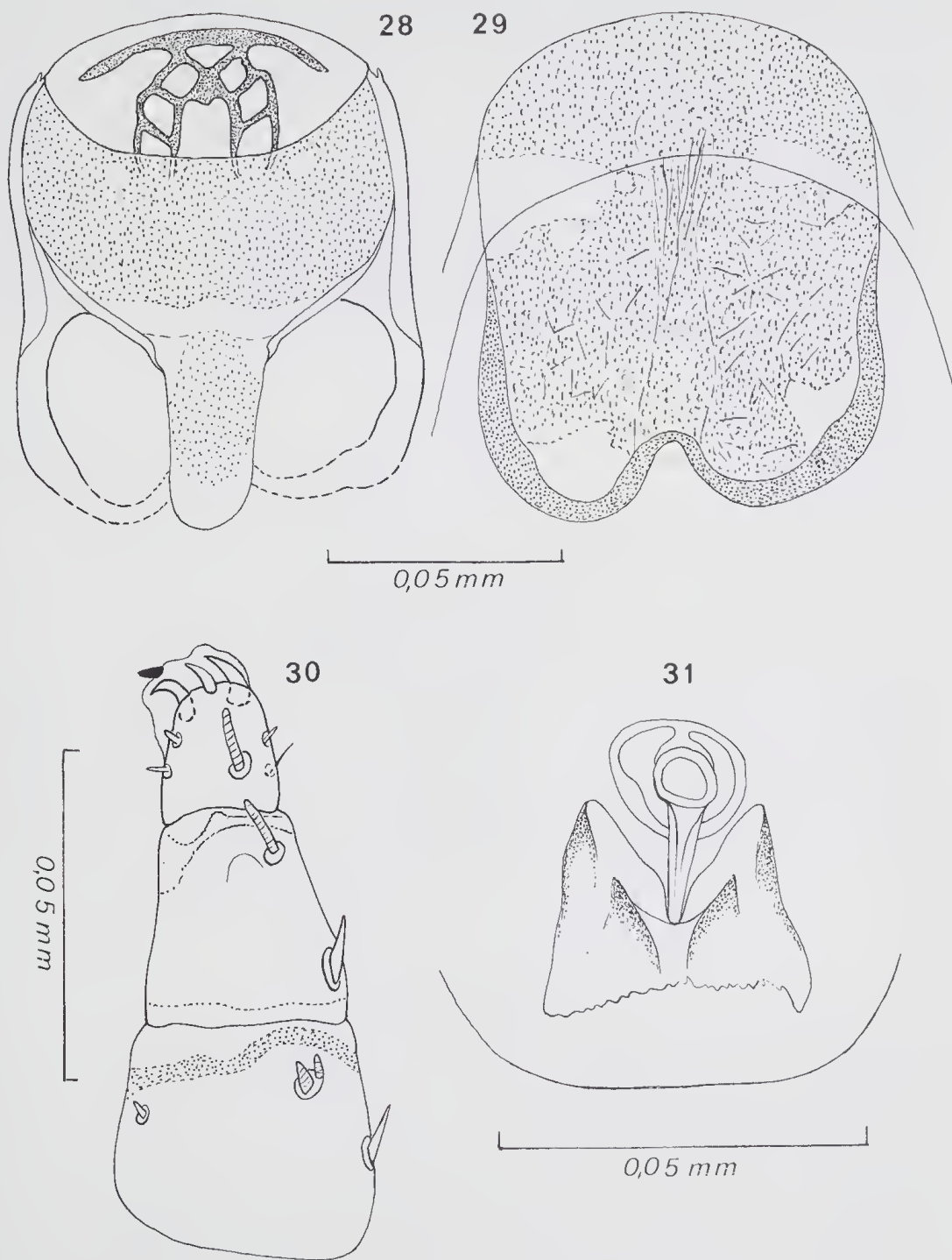
Dorsum: Cuticle of idiosoma behind the gnathosoma with faint transverse striations often interrupted. In swollen specimens these striations become indistinct. No punctations nor papillae on cuticle of body. Anterior part of idiosoma recovering gnathosoma with a distinct punctation, the base of this punctate area is more strongly sclerotized and deeply incised. Copulatory papilla subterminal. Bursa short.

Venter: Cuticle soft, without punctation or verrucosity. Epimerae I fused into a short sternum; other epimerae free. Epimera IV distinctly forked apically. Vulva forms an inverted Y. Anus subterminal ventral. Gnathosoma very large and rounded anteriorly, 108  $\mu$  long and 87  $\mu$  wide, its dorsal and ventral surfaces punctate; mouth cavity with a sclerotized structure in the shape of a network. Legs relatively well developed; all the tarsi shorter than the corresponding tibiae, bearing relatively long, curved and strongly attenuated apical spines; all these spines are enveloped by a short membrane bearing at its apex a small claw.



Fig. 27: *Cytodites geopoliae* sp. nov. Female in ventral view.





Figs 28-31: *Cytodites geopoliae* sp. nov. Fig. 28-30 — Female. Fig. 28-29 — Gnathosoma in ventral (28) and dorsal (29) view. Fig. 30 — Genu, tibia and tarsus I. Fig. 31 — Male: Aedeagus.

Male (Fig. 31): Allotype 480  $\mu$  long and 330  $\mu$  wide. Dorsal surface of body, gnathosoma and legs as in the female.

Venter: Epimera IV not forked apically. Genital organ as in *Cytodites amandavae* but relatively wider.

Systematic position of *Cytodites geopoliae*: This species is close to *C. tympanistriae*. It is however clearly distinguished from this species in the female by the following characters: gnathosoma relatively much larger, with dorsum entirely punctate and a different ventral pattern; idiosoma without verrucous areas; legs longer; differently shaped ambulacrar membranes of tarsi which bear a small apical claw; forked shape of epimerae IV.

#### Host and Locality

Holotype and 2 female paratypes, allotype and one male paratype from the trachea of *Geopelia humeralis* (Temminck), from Beagle Bay, 25.VIII.1976.

### ACKNOWLEDGEMENTS

This paper results from the combined Western Australia Field Programme 1976-77 between the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of Mr William S. and Mrs Janice Street, Ono, Washington, and the aid of grant R 87-111 by Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

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## PARASITES OF WESTERN AUSTRALIA

### III

#### *ALABIDOPUS MURIS* SP. NOV. (ACARINA: ASTIGMATA: GLYCYPHAGIDAE) FROM *RATTUS TUNNEYI*

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and

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#### ABSTRACT

*Alabidopus muris* sp. nov., a follicle inhabiting hypopus from *Rattus tunneyi* and the tritonymph are figured and described.

#### INTRODUCTION

In a previous paper, Fain (1967) described *Alabidopus hydromys* from *Hydromys chrysogaster reginae* from Queensland and erected the new subfamily Alabidopinae Fain, 1967, intermediate between Labidophorinae and Lophuromyopinae. Up to now the subfamily was known only from the heteromorph deutonymph of the type species. During the Western Australia Field Program 1976 the senior author collected hypopi of the genus from *Rattus tunneyi* and successfully reared them to tritonymphs, which enables us to confirm the systematic position of the subfamily. These hypopi are closely related to *A. hydromys* Fain, 1967. They differ mainly by broader body, closed coxal field III, stronger and more conical spines on metapodosoma, and shape and length of several leg setae. They are figured and described here.

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## ALABIDOPUS MURIS SP. NOV.

Hypopus (holotype) of ovoid shape, small size and white to pale yellow colour with brown legs and epimera. Length 245  $\mu$ , in 10 paratypes measured average 229  $\mu$  (207-248), width 152  $\mu$ , in paratypes 145 (128-163).

Venter (Fig. 1): Cuticle in region of gnathosoma, coxal field I and metapodosoma weakly sclerotized with tiny white spots; soft between epimera II and coxal field III. Epimera I fused in short Y-shape; epimera III and IV fused to closed coxal field III. Epimerites IV fused with small pregenital shield. Palposoma well formed with one pair of 16  $\mu$  long dentated setae and solenidia *alpha* on typical cylindrical prolongations. Short spines in coxal region I; broad 9-10  $\mu$  long spines in coxal regions III and IV. Opisthosoma strongly reduced. Genital region caudad with two pairs of genital suckers, in most paratypes pressed out of genital valves by preparation. They are inside the body in all the living specimens pressed out of follicles and kept in rearing vials. Genital anterior and median setae setiform (11, 14). Pilicolous organ and claspers absent. Legs inserted almost laterally.

Dorsum (Fig. 2): Cuticle, with exception of a soft region along sejugal furrow, sclerotized with tiny white spots. Present are: serrated setae *vi* (17), *ve* (6), *sh* (10); long spines with rounded end *sci* (9-10), *se* (9-10), *d1* (9), *l1* (9); broader conical spines dorsals 2-4 (9, 8, 7), laterals 2-5 (8, 8, 7, 5); tiny spines *d5*, *ai* and *ae* and setiform supracoxals (9). Anal pore is situated toward dorsum. Dorsal glands between laterals 2 and 3, pores near humerals.

Legs (Figs 3-5) with very short pretarsus and long curved claws (11, 10, 6, 5), strongly curved in legs I and II, more stretched in hind legs. All tarsi relatively long (30, 30, 40, 33). Tarsus IV with strong, 114  $\mu$  long seta. Trochanters III and IV with forwardly directed spurs. Broadened tibial setae III and IV deeply inserted with three distinctly unequal dentations. Genua and tibiae III and IV shortened. Chaetotaxy of legs: tarsi 8-8-8-8, tibiae 2-2-1-1, genua 2-2-1-0, femora 1-1-0-0, trochanters 1-1-1-0. Solenidiotaxy as generally in hypopi of family: *omega* 1 (13), *omega* 3 (5), *omega* II (12), *phi* I-IV (51, 14, 5, 3), sigma I and II (5, 5), famulus present.

### Rearing Tests

Hypopi pressed out of hair follicles from female hosts together with the skin irritations of infected hosts were used for rearing tests. They were put into 10 ml glass vials and covered with dense cloth material. The vials were



then placed in cans containing about 1 cm of water and almost closed. The cans were deposited in shade amongst the roots of Pandanus palms just above the water level of a pool. Daily observations showed that the first tritonymphs were present on the third day; on the fifth day all the specimens were dead. Death was obviously caused by the extremely high temperatures (maximum in shade 45°C, minimum 33°C).

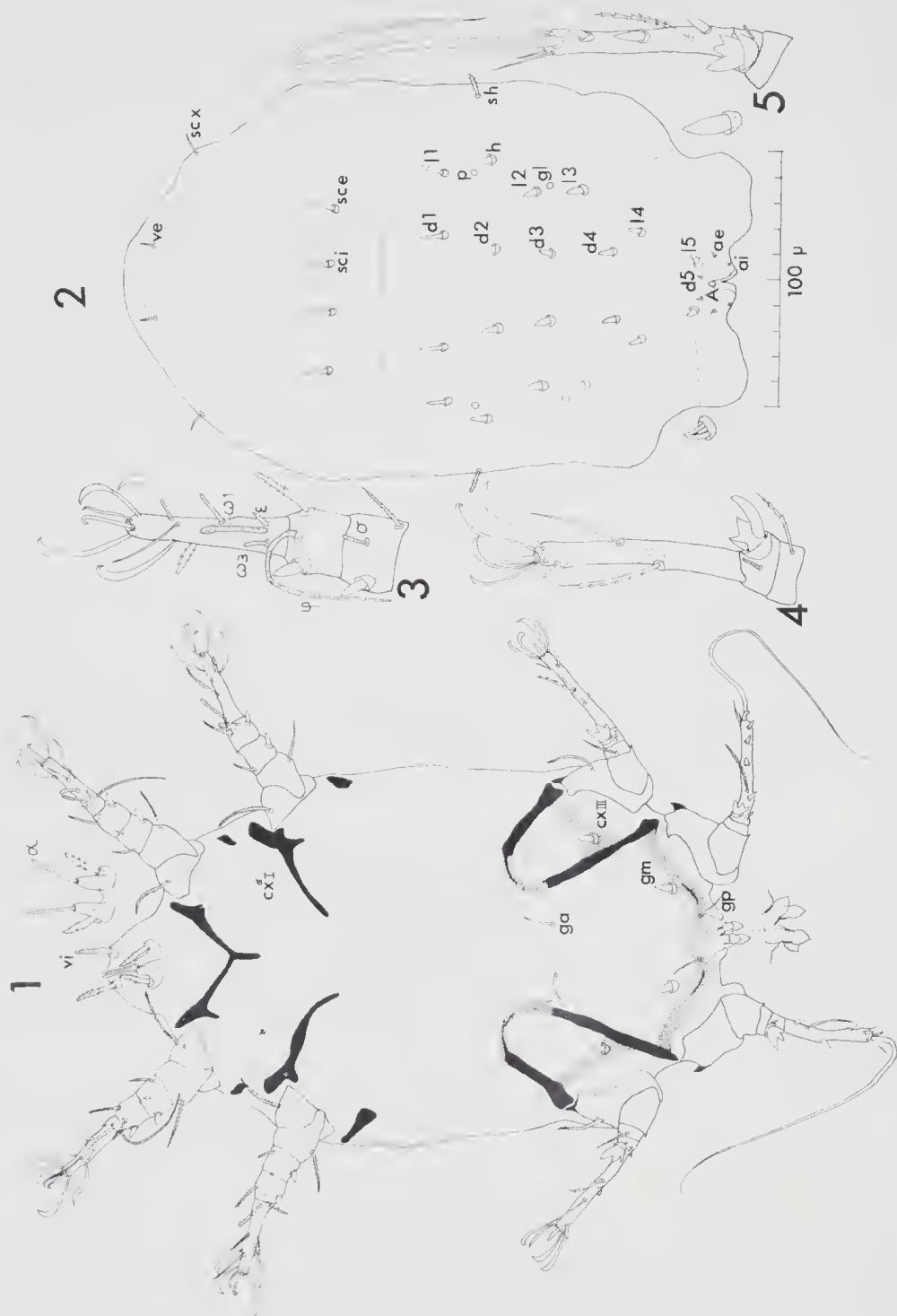
Tritonymph (allotype) of ovoid shape and white colour. Cuticle with tiny transverse striations without tiny spines as in tritonymphs and adults of subfamily Labidophorinae and without remarkable sclerotization as in subfamily Ctenoglyphinae, or verrucose structures as in Lophuromyopinae. Lateral view shows only very slight elevations between the striations. Supplementary larger striations present in metapodosomatal region. Length 275  $\mu$ , average 268  $\mu$  from 10 paratypes measured (248-295), width 142  $\mu$ , average in paratypes 153 (127-174).

Venter (Fig. 6): Epimera I fused in short Y-shape, epimera II-IV and epimerites free and only weakly sclerotized. Setiform coxal setae in fields I (15) and III (10), *ga* (9), *gm* (8), *gp* (8). Genital region between legs IV with two pairs of two-segmented genital suckers. Position of suckers differs in the reared specimens: in allotype and four paratypes they are lying in one row of four suckers (Fig. 6), in three paratypes in a row of three suckers with the fourth on the opposite side, and in 16 specimens in normal situation (see figure). Anal region with three pairs of short anal setae (7, 9, 8). Gnathosoma with well sclerotized functional chelicerae and normal palps.

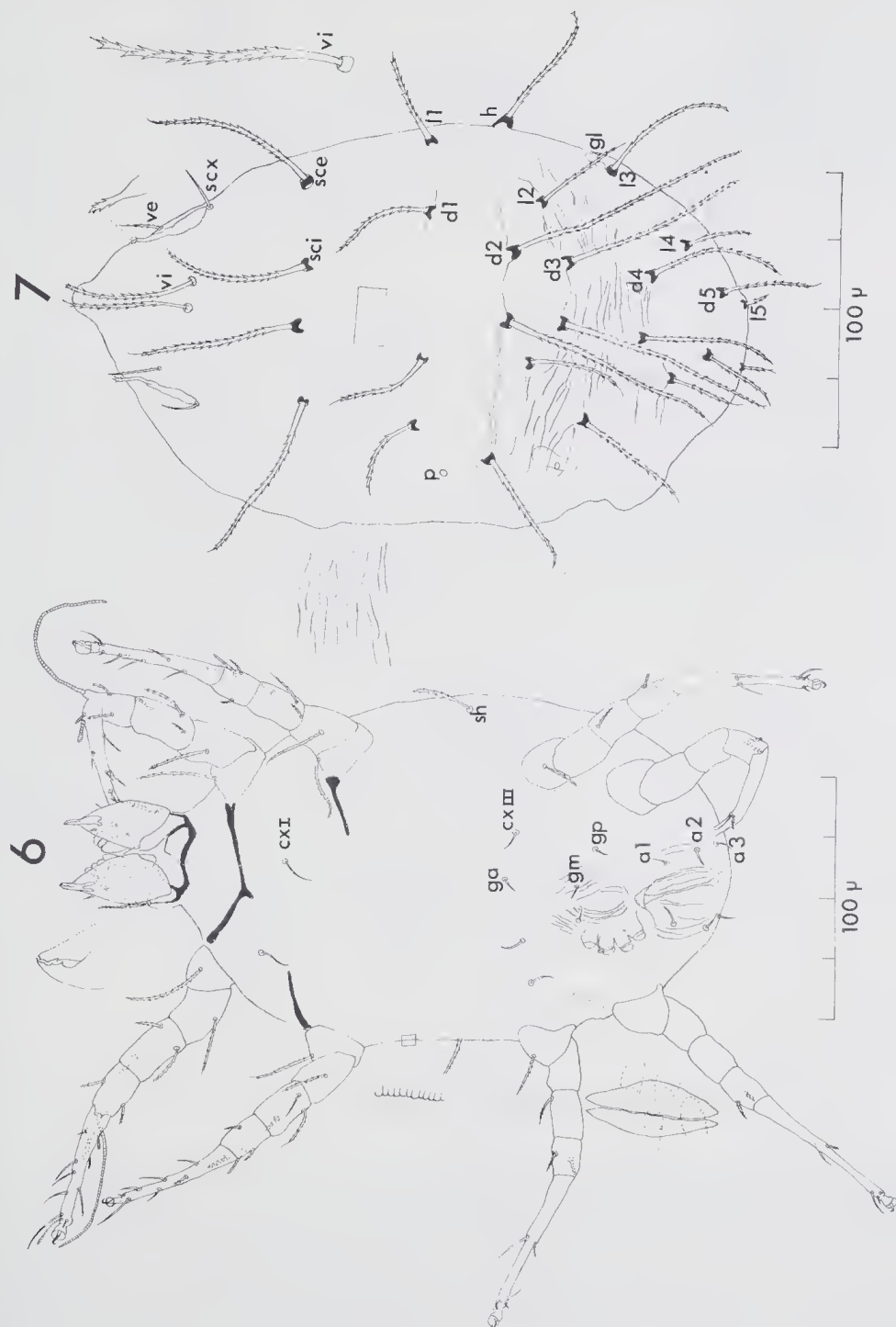
Dorsum (Fig. 7) without sejugal furrow. All dorsal setae, with exception of setiform supracoals (17), relatively strong with short strong pectinations. Most setae on stronger sclerotized protuberances. Present are: *vi* (50), *ve* (14), *sci* (68), *se* (75), dorsals 1-5 (44, 95, 84, 51, 37), laterals 1-5 (36, 43, 55, 28, 14) and humerals (55). Dorsal glands near laterals 3, pores near lateral 1. Grandjean organ well formed, 34  $\mu$  long with hairlike cuticular prolongations.

Legs (Figs 8-10) with stalked pretarsus, carrying a strong short curved claw. All tarsi long (50, 50, 59, 60). Chaetotaxy of legs: tarsi 8-8-6-6, tibiae 2-2-1-1, genua 2-2-1-0, femora 1-1-0-0, trochanters 1-1-1-0. Solenidiotaxy: tarsi 3-1-0-0, tibiae 1-1-1-1, genua 1-1-0-0. *Omega* 1 on protuberance (10), *omega* 2, 3 (6, 13), *omega* II (9), *phi* I on typical strong protuberance surpassing apical border of tibia as in species of genus *Xenoryctes* Zachvatkin, 1941. *Phi* I-IV (74, 16, 6, 6), *sigma* I and II (9, 7), *famulus* present.

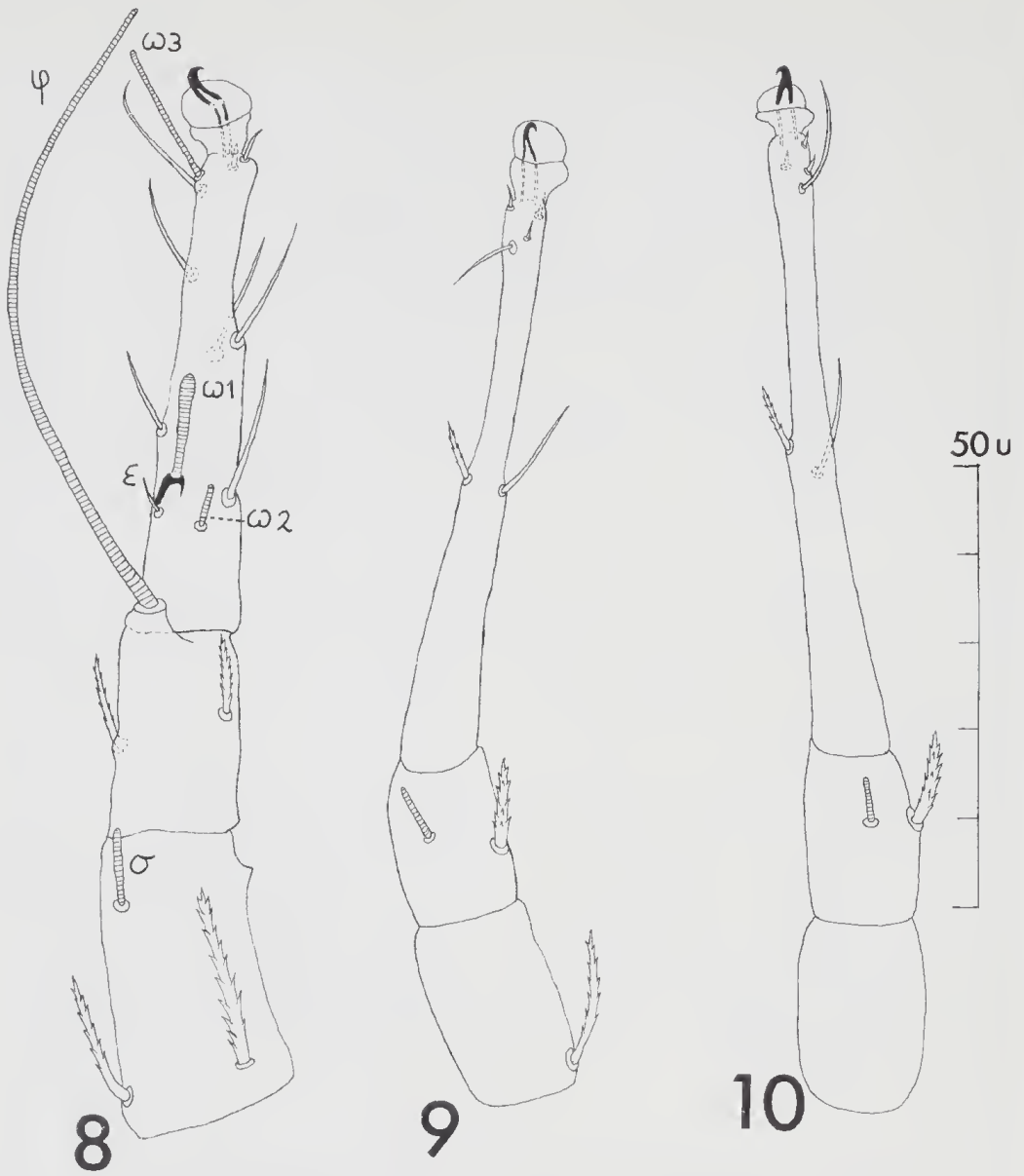




Figs 1-5: *Alabidopus muris* sp. nov., holotype venter (1), dorsum (2), legs I (3), III (4) and IV (5).



Figs 6-7: *Alabidopus muris* sp. nov., allotype tritonymph venter (6) and dorsum (7).



Figs 8-10: *Alabidopus muris* sp. nov., legs I (8), III (9) and IV (10).

### Systematic Position of Genus *Alabidopus*

Without adult specimens it is difficult to determine the exact position of the genus *Alabidopus*. Based on the tritonymph, it appears that this genus belongs to the family Glycyphagidae. The absence of distinct cuticular ornamentation suggests that it does not belong to the Glycyphaginae nor to

the other subfamilies of Glycyphagidae (Lophuromyopinae, Ctenoglyphinae).

### Host and Locality

*Rattus tunneyi* (Thomas, 1904), Mount Hart, 10, 12, 14 September 1976, Port Warrender, 28, 29, 30 October 1976, collected by mammal group of expedition, coll. nos 2679, 2681, 2700, 2707, 3099, 3106, 3112, 3137 and 3140. Hosts in Field Museum of Natural History, Chicago, and Western Australian Museum, Perth.

### Pathology

The mites were found in hair follicles of dorsum of hosts above pelvis and vertebral column. They caused skin irritations and loss of hair. In strong infections, irritations were mange-like. Several hypopi were found to inhabit one follicle. They were situated with the head part towards follicle opening. Morphological adaptations for anchoring hypopi within follicles are the spurs of trochanters III and IV, forwardly directed spines of dorsum, spines of leg segments, especially broadened tibial spines III and IV, and forward and outward moving legs III and IV.

### Deposition of Types

Holotype and allotype in Western Australian Museum, Perth; numerous paratypes in Perth; Field Museum of Natural History, Chicago; U.S. National Museum of Natural History, Washington, D.C.; The Acarology Laboratory, Columbus, Ohio; British Museum (Natural History), London; Muséum National d'Histoire Naturelle, Paris; Institute of Parasitology, Prague; Zoologisches Museum, Hamburg; Forschungsinstitut Senckenberg, Frankfurt; Bernice P. Bishop Museum, Honolulu; Institut de Médecine Tropicale Prince Léopold, Antwerp; Zoologisch Laboratorium, Nijmegen.

## ACKNOWLEDGEMENTS

This paper results from the combined Western Australia Field Programme 1976-1977 between the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of William S. and Janice Street, Ono, Washington, and the aid of grant R87-111 by the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

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## PARASITES OF WESTERN AUSTRALIA

### IV

## OBSERVATIONS ON THE GENUS *MARSUPIOPUS* FAIN, 1968 (ACARINA: ASTIGMATA: GLYCYPHAGIDAE)

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### ABSTRACT

A new species found in the tail follicles of *Zyzomys argurus* is described and figured. Tritonymphs and adults have been reared and confirm the systematic position. Pathological reaction of host tissues results in amputation of tail parts.

### INTRODUCTION

In a former study Fain & Lukoschus (1976) described three new species and one new subspecies and compared them with the known species of the genus *Marsupiolopus* Fain, 1968. The genus was known only from the hypopial stage, parasitic on mammals and restricted to Australia. Systematic arrangement in the family Glycyphagidae Berlese, 1887 is based on morphology of hypopi only. During the Western Australia Field Programme one of us (F.S.L.) was able to collect further specimens, rear hypopi through to adults and observe the pathology in *Zyzomys argurus* (Thomas, 1889). For the first time adults of the subfamily Marsupiolopinae Fain, 1968 are described, confirming the systematic arrangement.

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# MARSUPIOPUS ZYZOMYS SP. NOV.

This species is closely related to *M. antechinus* Fain & Lukoschus, 1976. Hypopi differ mainly by indistinct sejugal furrow, longer tarsi I, longer tibia I solenidion and several other measurements, which are given in Table 1.

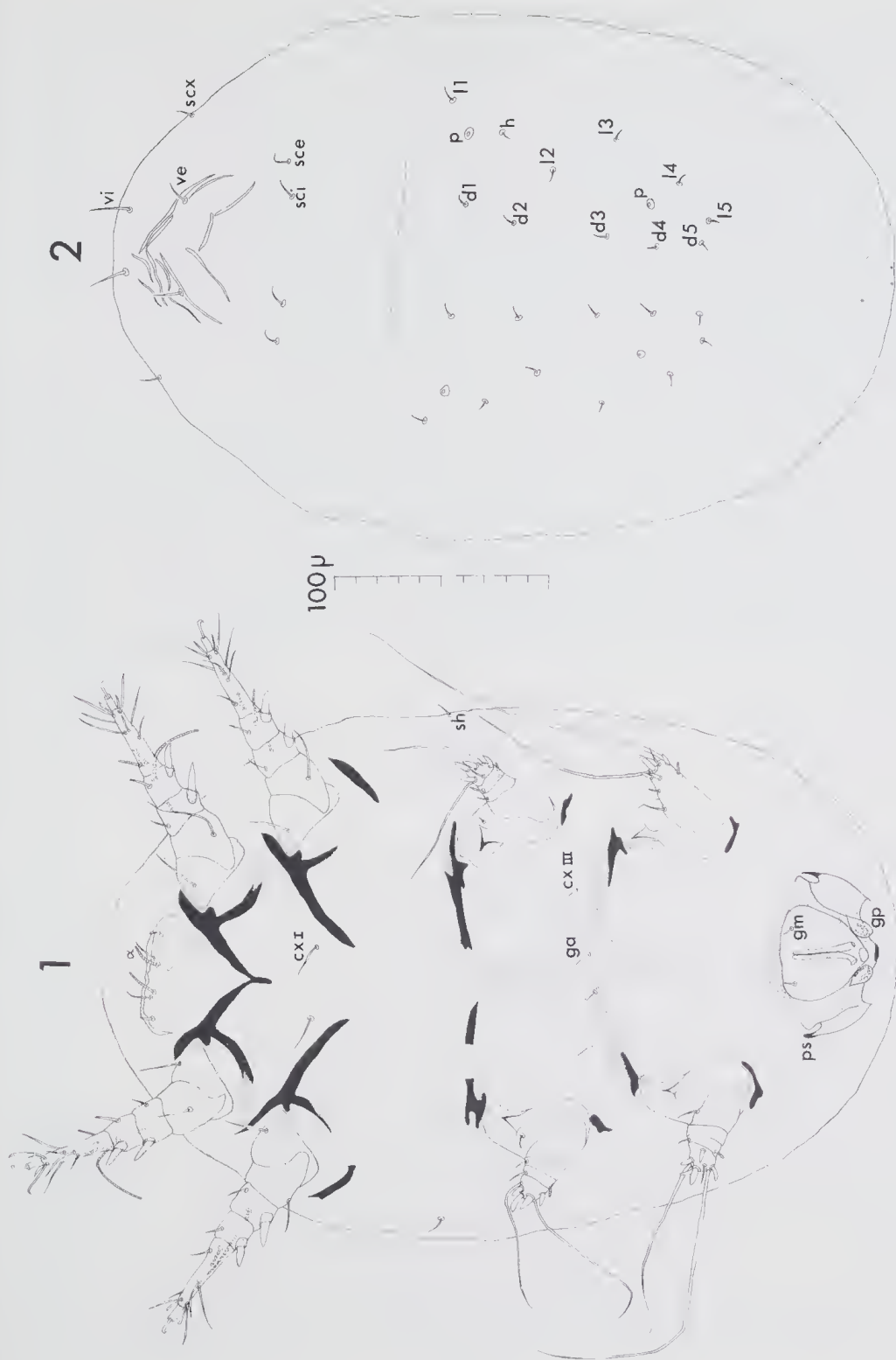
Table 1: Comparison of measurements (in  $\mu$ ) of hypopi of *Marsupius antechinus* Fain & Lukoschus, 1976 and *M. zyzomys* sp. nov.

	zyzomys			antechinus		
cx I, cx III	16	10		10	7	
ga, gm	10	11		6	6	
vi, ve	19	14		15	10	
sci, sce	10	9		10	11	
h, sh, scx	6	9	10	6	7	9
dorsal 1-5	7, 7, 7, 6, 6			7, 11, 12, 9, 7		
laterals 1-5	6, 6, 6, 6, 6			8, 8, 8, 9, 10		
tarsus I-IV	33, 34, 11, 12			21, 21, 10, 10		
pretarsus I, II	10	10		6	6	
claw I, II	10	9		8	8	
omega 1, 3, II	11	9	11	14	9	12
phi I-IV	40, 25, 7, 5			29, 16, 9, 7		
alpha		14			14	
alpha-alpha		15			13	
palposomal setae						
internal, external	14	7		16	10	
perigenital ring						
width		77			60	
length		52			54	

Hypopus (holotype) with unornamented white cuticle of ovoid shape, showing the characteristics of the genus. Length 364  $\mu$ , in 10 paratypes measured average 343  $\mu$  (306-366); width 242  $\mu$ , average in paratypes 217 (193-245).

Venter (Fig. 1): Cuticle white and smooth, legs and epimera yellow-brown. Epimera I fused in short Y-shape, epimera III and IV fused with median pregenital sclerite. Palposoma well marked with solenidia *alpha* and two unequal pairs of setae. Two small rings behind solenidia. Genital region with



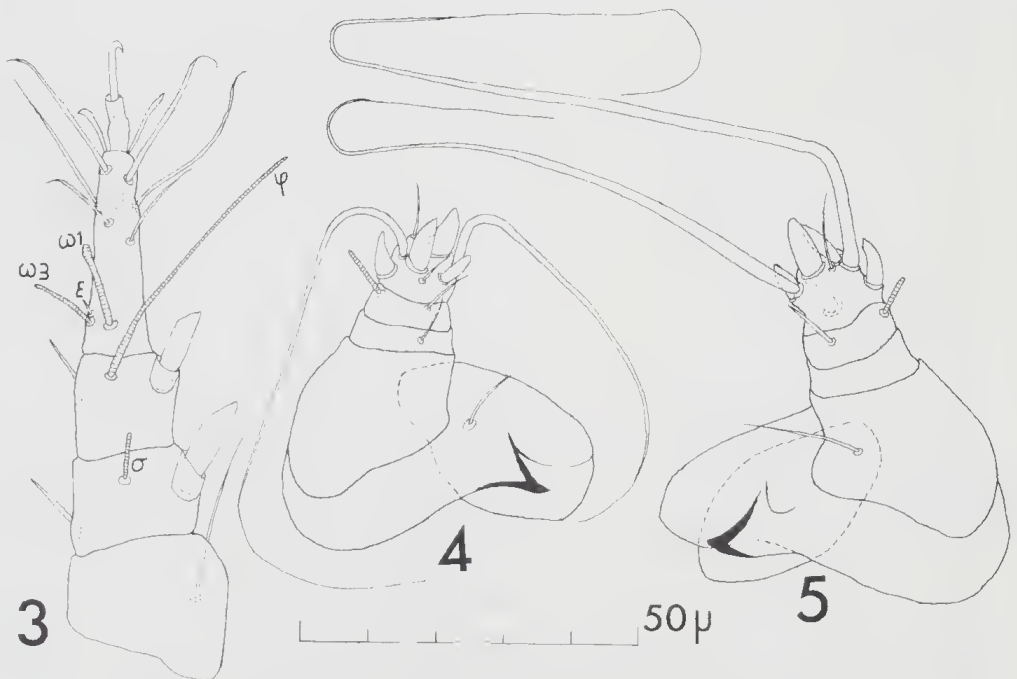


Figs 1-2: *Marsupiopus zyzomys* sp. nov., hypopus, holotype venter (1), dorsum (2).

sclerotized perigenital ring carrying lateral spurs, arising from ventral surface (Fig. 21, *ps*), setiform *gm* and disc-like *gp*, which apparently have adhesive function. Genital suckers (*gs*) two-segmented beneath genital valves (*gv*) in median direction (Fig. 20). Anus (A) distinct and opening into genital atrium. Coxal setae present in fields I and III, genital anterior on epimera IV.

Dorsum (Fig. 2): Cuticle weakly sclerotized with tiny spots in region between laterals 4 and 5. Irregular grooves in propodosomatal region. Sejugal furrow within a transverse region of soft cuticle indistinct, in many paratypes not observable. Present are all idiosomatal setae in short setiform shape. Dorsal gland between *d* 3 and *l* 4, pore between *l* 1 and *h*.

Legs (Figs 3-5) with five free segments. Legs I and II of strong normal shape with pretarsus and sickle-shaped claw, setiform femoral hair; legs III and IV short, stout, directed forwards, without pretarsus and claw. The spurs on trochanters III and IV and deeply inserted strong spines on tibiae and genua I and II serve together with the lateral spurs of perigenital ring and disc-like *gp* to anchor the hypopus within the hair follicle of host. Chaetotaxy of legs: tarsi 9-9-8-8, tibiae 2-2-1-1, genua 2-2-1-0, femora 1-1-0-1, trochanters 1-1-1-0. Solenidiotaxy: tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-0-0. Famulus present. Shape of setae in figures, measurements in Table 1.



Figs 3-5: *Marsupiopus zyzomys* sp. nov., hypopus, legs I, III, IV.

## REARING EXPERIMENTS

Eleven rearing tests were started between 30 August and 19 September 1976. Hypopi of severely infected female hosts pressed out of hair follicles were placed in 10 ml glass vials together with sebaceous fat and skin scales scraped off from host tail and with parts of tail. The vials tops were covered; some with densely woven cloth material, others with plastic stoppers. To maintain the necessary high humidity, small strips of wet paper were put into the stopper-closed vials, while the cloth-closed vials were placed in cans with about 1 cm of water and the can top almost closed. To get relatively low temperatures, cans were stored in continuously shadowed rock clefts or between the roots of *Pandanus* palms just above the water level of pools. Hypopi samples, taken from hosts trapped alive and killed before storing in an ice-box for one day, gave rise to tritonymphs after three to four days (good results of trapping lines could not be observed immediately, they were preserved in an ice-box for later investigation and skinning). Vials were observed daily and specimens preserved in alcohol after 10 days or when mites were found dead. Tests were done in the middle of the dry season when temperatures were up to 45°C. Death of mites was obviously caused by the high temperatures.

Tritonymph of white to pale yellow colour; ovoid shape with the characteristics of family Glycyphagidae. Total length of figured specimen 369  $\mu$ , average 390  $\mu$  from 10 paratypes measured (343-432), width 195  $\mu$  average in paratypes 230 (193-249).

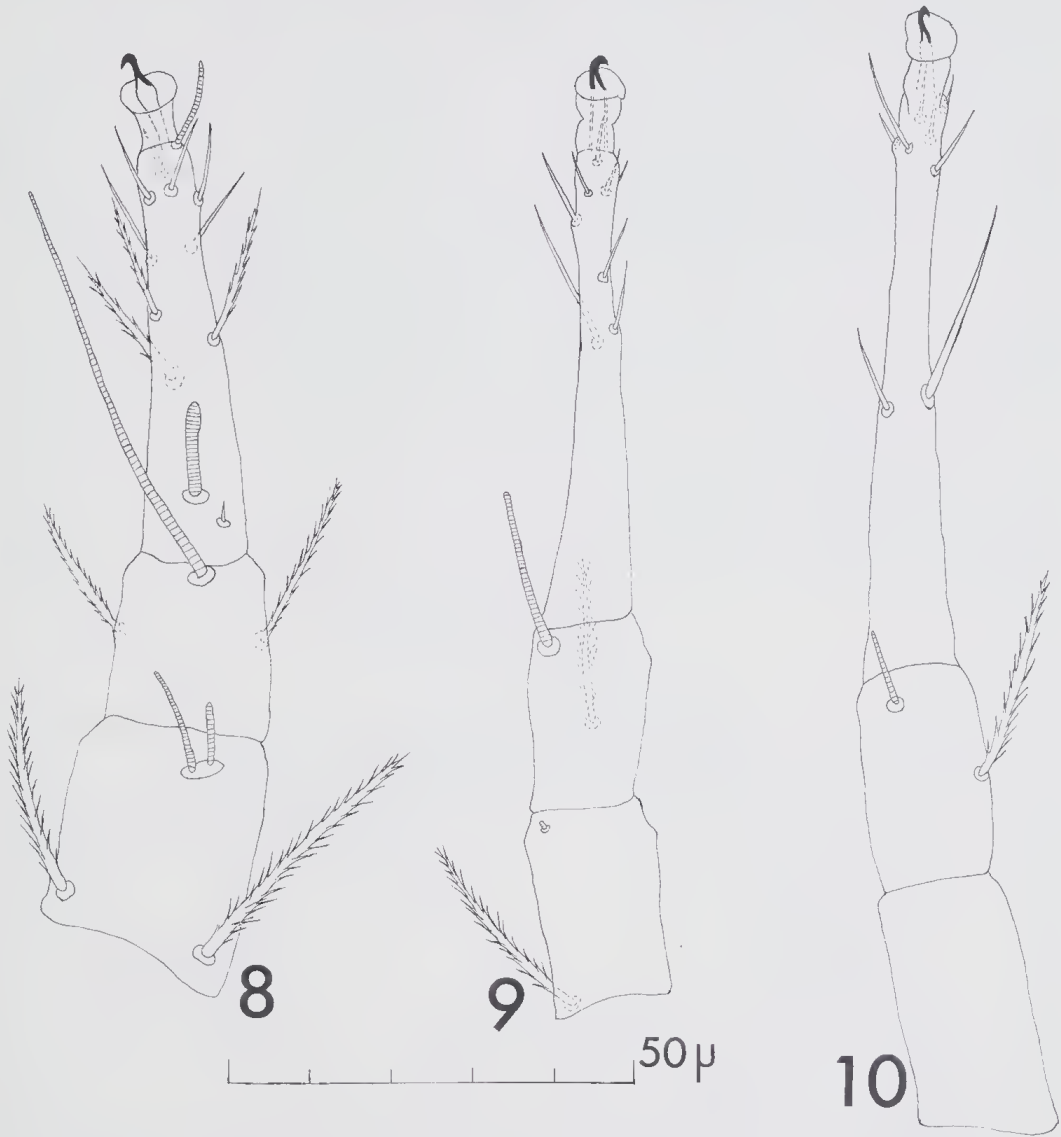
Venter (Fig. 6): Epimera I fused in V-shape, II-IV free, epimerites absent. Genital region between legs IV with two pairs of 8  $\mu$  small normal shaped genital suckers. Anal split 48  $\mu$  long with three pairs of anal setae (*a* 1, *a* 3, *a* 5). Gnathosoma with dentated chelicerae, palps with two free segments, which carry two setae and one solenidion, and two pairs of setae on pedipalpal coxae and labrum. Coxal setae in fields I and III, three pairs of genital setae (*g* *a*, *g* *m*, *g* *p*). Subhumeral unusually situated toward dorsum.

Dorsum (Fig. 7): Cuticle almost soft with numerous very small cuticular elevations with rounded top. Sclerotized shields or crista and sejugal furrow absent. All dorsal setae *Glycyphagus*-like densely pectinated and long, with exception of *d* 2, *d* 3, *h* and *l* 2, which are remarkably short. Supracoxal seta thick and densely pectinated, Grandjean organ with bilid hairy end. Small dorsal glands near laterals 2.

Legs (Figs 8-10) with long tarsi, stalked pretarsi and small empodial claws of subequal shape. Chaetotaxy of legs: tarsi 9-9-8-8, tibiae 2-2-1-1,

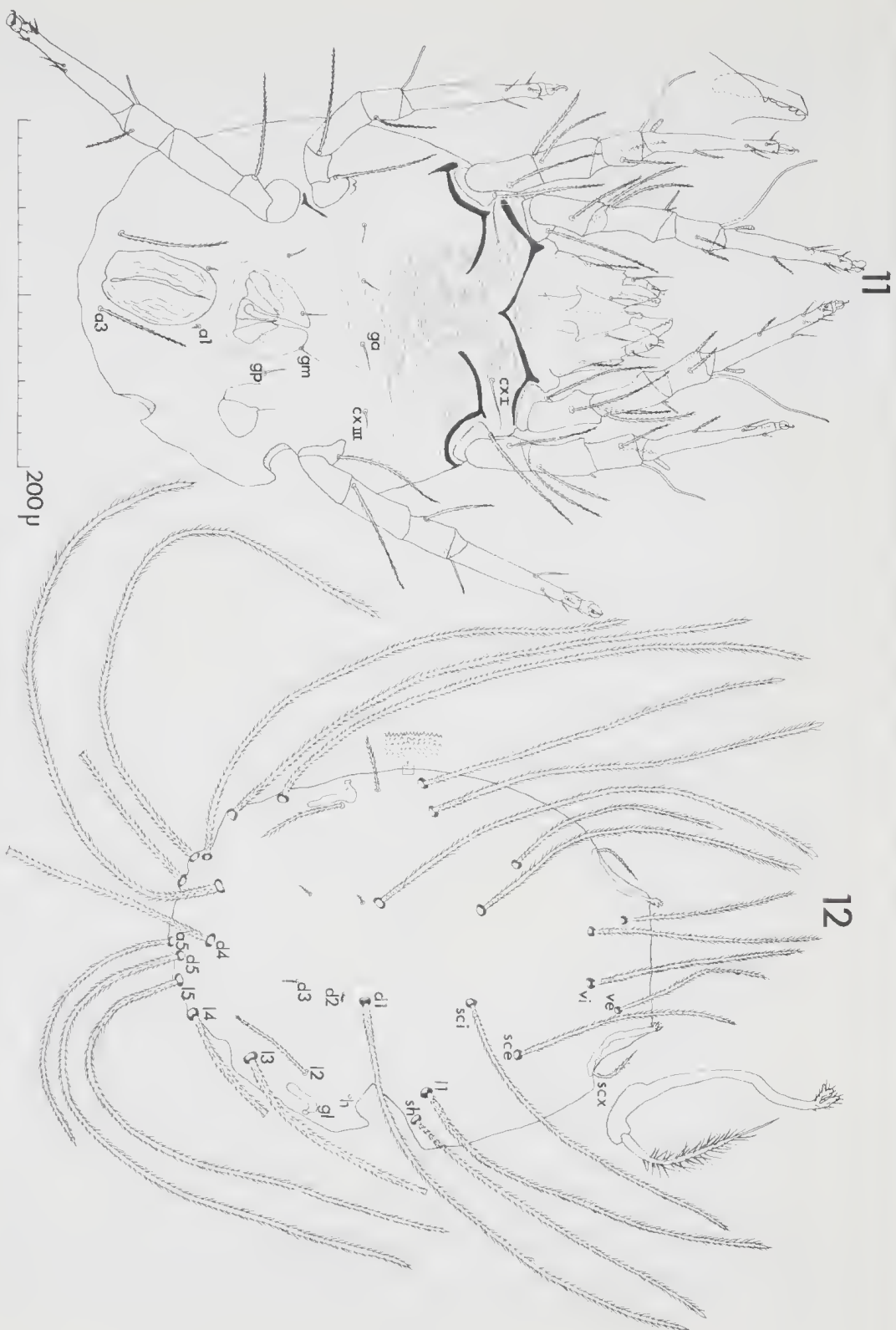


genua 2-2-1-0, femora 1-1-0-1, trochanters 1-1-1-0. Solenidiotaxy: tarsi 2-1-0-0, tibiae 1-1-1-1, genua 2-1-1-0. Famulus present. Leg setae mostly pectinated, no specialized setae present. Measurements in Table 2.



Figs 8-10: *Marsupiopus zyzomys* sp. nov., tritonymph, legs I (8), III (9) and IV (10).

Male (Fig. 11) of white to pale yellow colour, with soft cuticle, carrying numerous small cuticular elevations with rounded top. These cuticular formations are different from free-living *Glycyphagus* species and adults of 'phoretic' species living during hypopial stage on mammals, like *Glycyphagus*





(*Myacarus*) *hypudaei* (Koch, 1841), *Marsupialichus marsupialis* Fain et al. 1972, *Zibethacarus ondatrae* (Rupes & Whitaker, 1968), *Lophioglyphus liciosus* Volgin, 1941 (= *Apodemopus apodemi* Fain, 1965), *Baloghella melis* Mahunka, 1963 (= *Melesodectes auricularis* Fain & Lukoschus, 1968), *Dermacarus sciurinus* Koch, 1841. Epimera I fused in V-shape, II-IV free and faintly developed. Genital region between legs IV with 20  $\mu$  short penis, genital apodemes and two pairs of small genital suckers. Anal region ventral subterminal with 60  $\mu$  long anal split and three pairs of anal setae. Gnathosoma like in tritonymph with dentated chelicerae. In coxal regions I and II beside cuticular elevations many transverse striations of weave-like appearance. Cuticle in genital region smooth. Length 345  $\mu$ , width 215  $\mu$ .

Dorsum (Fig. 12) generally as in tritonymph, without sclerotized shields or crista and without sejugal furrow. All dorsal setae longer and stronger pectinated than in tritonymph with exception of dorsal 2 and 3, which are considerably thinner and shorter. Grandjean organ with trifid end.

Legs (Figs 13-16) with long tarsi of subequal length, stalked pretarsi and empodial claws. Pretarsi in hind legs larger than in forelegs. Chaetotaxy and solenidiotaxy like in tritonymph, no specialized setae present. Measurements in Table 2.

Table 2: Measurements (in  $\mu$ ) in stages of *Marsupiopopus zyzomys* sp. nov.

	male			female			tritonymph		
<i>cx I, cx III</i>	29	12		34	21		22	16	
<i>ga, gm, gp</i>	14	15	14	16	5	18	12	7	14
<i>vi, ve</i>	130		96	103		77	75		56
<i>sci, sce</i>	204		130	163		98	122		53
dorsal 1, 2, 3	283	6	10	190	5	10	154	9	19
4, 5	359		356	283		277	208		197
lateral 1, 2, 3	231	53	324	163	34	230	133	26	172
4, 5	324		350	257		235	163		144
<i>scx, h, sh</i>	32	31	214	29	26	164	28	16	97
tarsus I-IV	74, 76, 80, 78			79, 81, 80, 93			48, 48, 56, 61		
<i>phi</i> I-IV	73, 41, 26, 16			64, 46, 23, 14			53, 34, 13, 8		
<i>omega</i> 1, 3, II	13	11	10	10	10	10	9	8	10
anal 1, 2, 3	5	-	60	5	6	41	6	-	29
4, 5, 6	-	167	-	20	126	47	-	63	-



Figs 13-16: *Marsupiopus zyzomys* sp. nov., male legs I-IV.

Female (Fig. 17): Fairly sclerotized specimen, pressed out of tritonymph during mounting, similar to tritonymph and male. Length  $350\ \mu$ , width  $209\ \mu$ . Large genital region between legs III and IV with two  $80\ \mu$  long valves, two pairs of small ( $8\ \mu$ ) genital suckers and little epigynium (*eg*), not connected to epimera. Anus terminally with six pairs of anal setae. Coxals, genitals and two pairs of anals setiform, all other idiosomatal setae long and pectinate, somewhat shorter than in male. Copulatory tube  $22\ \mu$  long dorsally in front of anal split. Legs like in male. Measurements in Table 2.

#### Host and Localities

*Zyzomys argurus* (Thomas, 1889) from the following places of Kimberley region: Napier Downs, 30 August-3 September 1976 (field numbers 2640, 2641, 2643, 2644, 2647, 2653, 2662), Mount Hart, 11-13 September (2690, 2693, 2701 host of type), Beverley Springs, 18-22 September (2726, 2731, 2734, 2737, 2738, 2792, 2794), Brooking Springs, 28 September 1976



(2810, 2813, 2814), Mitchell Plateau, 19-29 October 1976 (Western Australian Museum registration numbers M15538, M15594, M15609). All hosts trapped by mammal group of Western Australia Field Programme. Mitchell Plateau specimens were identified by D. Kitchener, Western Australian Museum, Perth; specimens from other listed localities were identified by L.E. Keller, Field Museum of Natural History, Chicago.

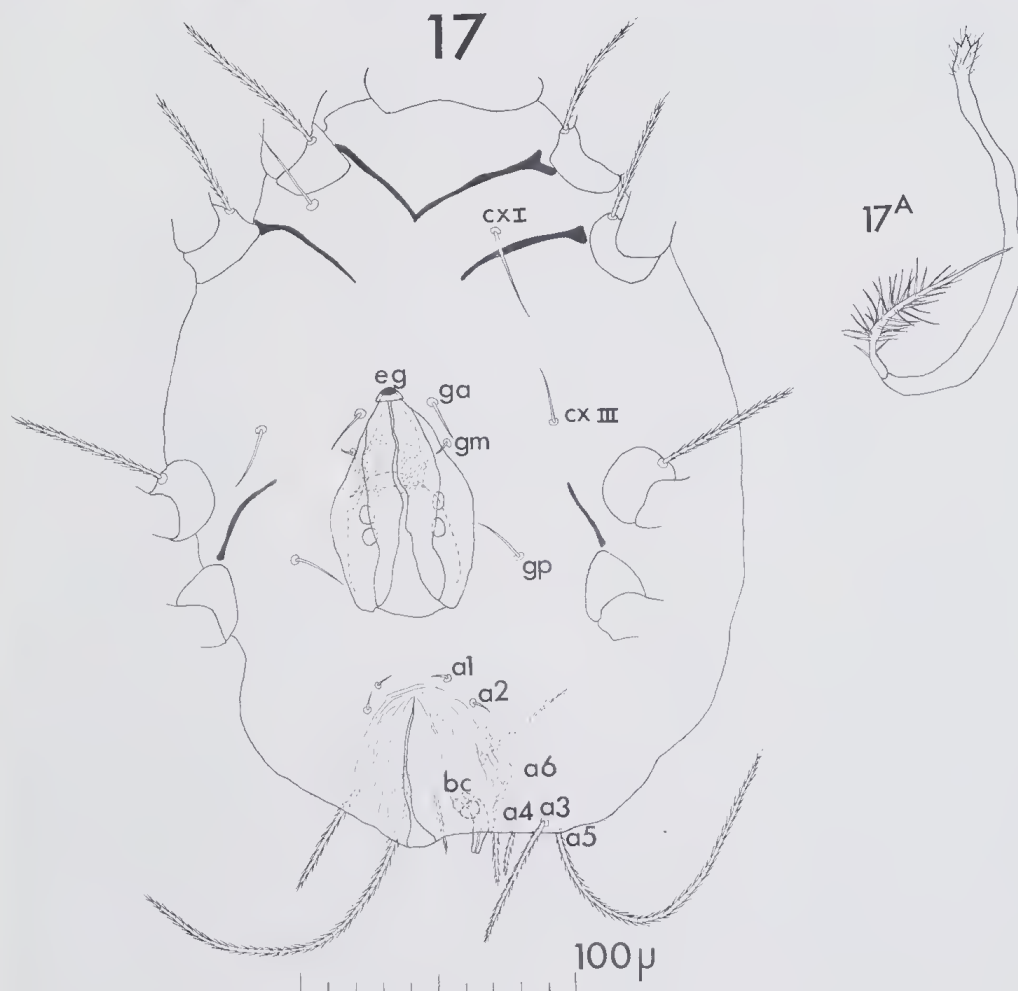


Fig. 17: *Marsupiopus zyzomys* sp. nov., female venter.

Fig. 17A: *Marsupiopus zyzomys* sp. nov., supra coxal seta and grandjean's organ.

## Pathology

Hypopi live in hair follicles of tail; they have not yet been found in other places on hosts. Infected follicles are often marked by larger amounts of hyperkeratosis between tail scales and by dark ring around follicle opening.

18



Fig. 18: Tails of *Zyzomys argurus* (a) young specimen with thin tail, (b) subadult with starting fat deposition in tail, (c) subadult with partial loss of tail skin, (d) adult with amputated tail.



Fig. 19: Histological section of tail skin of *Zyzomys argurus* infected by *Marsupipus zyzomys hypopus*. (For meaning of symbols see text.)



Histological sections (Fig. 19) show part of epidermis (*Ep*) of tail with hyperceratosis (*hc*) of infected hair follicle in comparison with non-infected follicle around hair (*H*). Wall of follicle indicates the degenerative characteristics (*deg*) of extra-intestinal digestion, known from feeding places of chiggers and ticks. Hypopi do not possess mouth parts and mouth opening and feeding is not yet studied. Sebaceous glands (*s.gl*) are strongly swollen in infected parts and connective tissues show disarrangements and degeneration. Part of the hairs of infected follicles are lost.

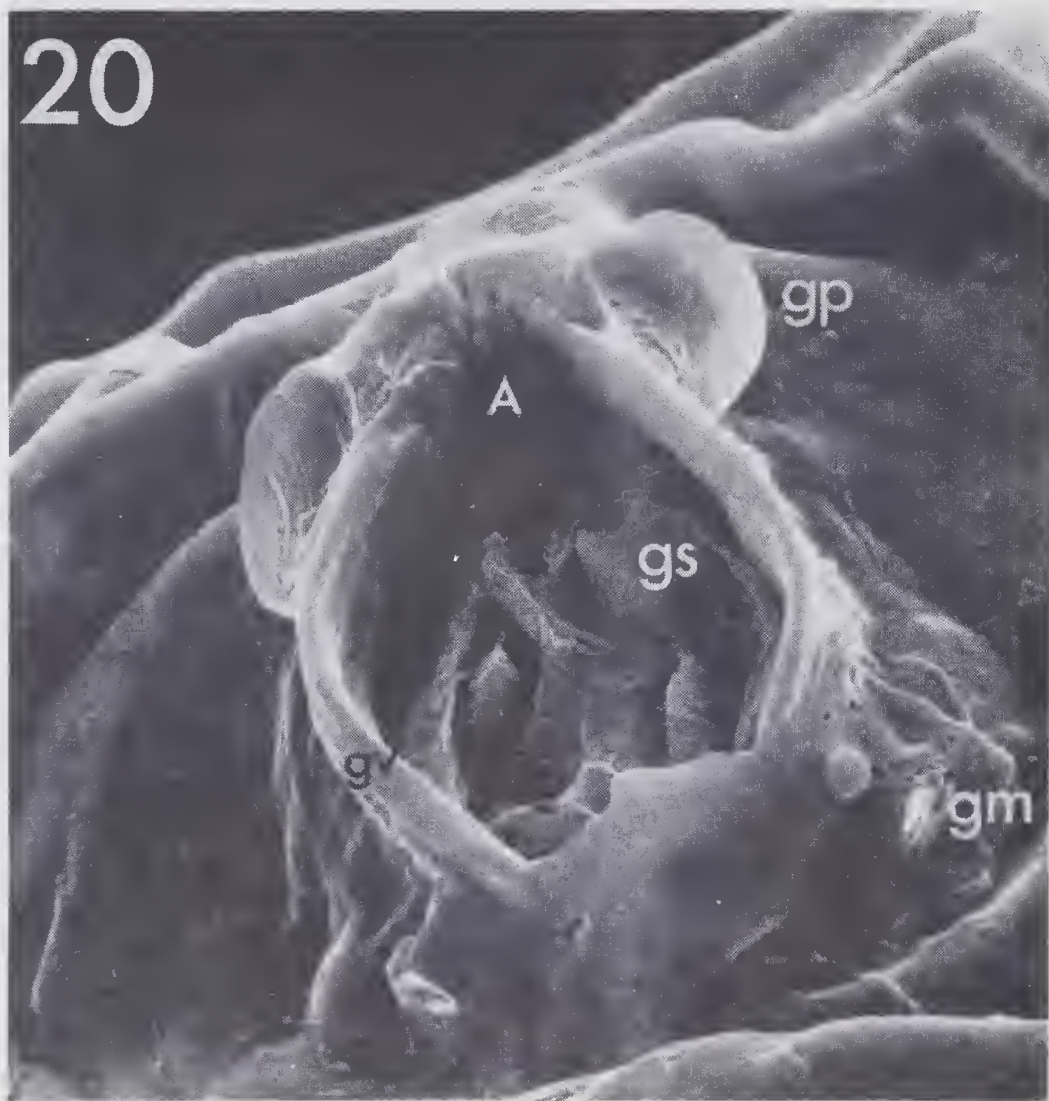


Fig. 20: Scanning picture of genital region of *Marsupiopus zyzomys* hypopus showing genital suckers and anal opening. (For meaning of symbols see text.)

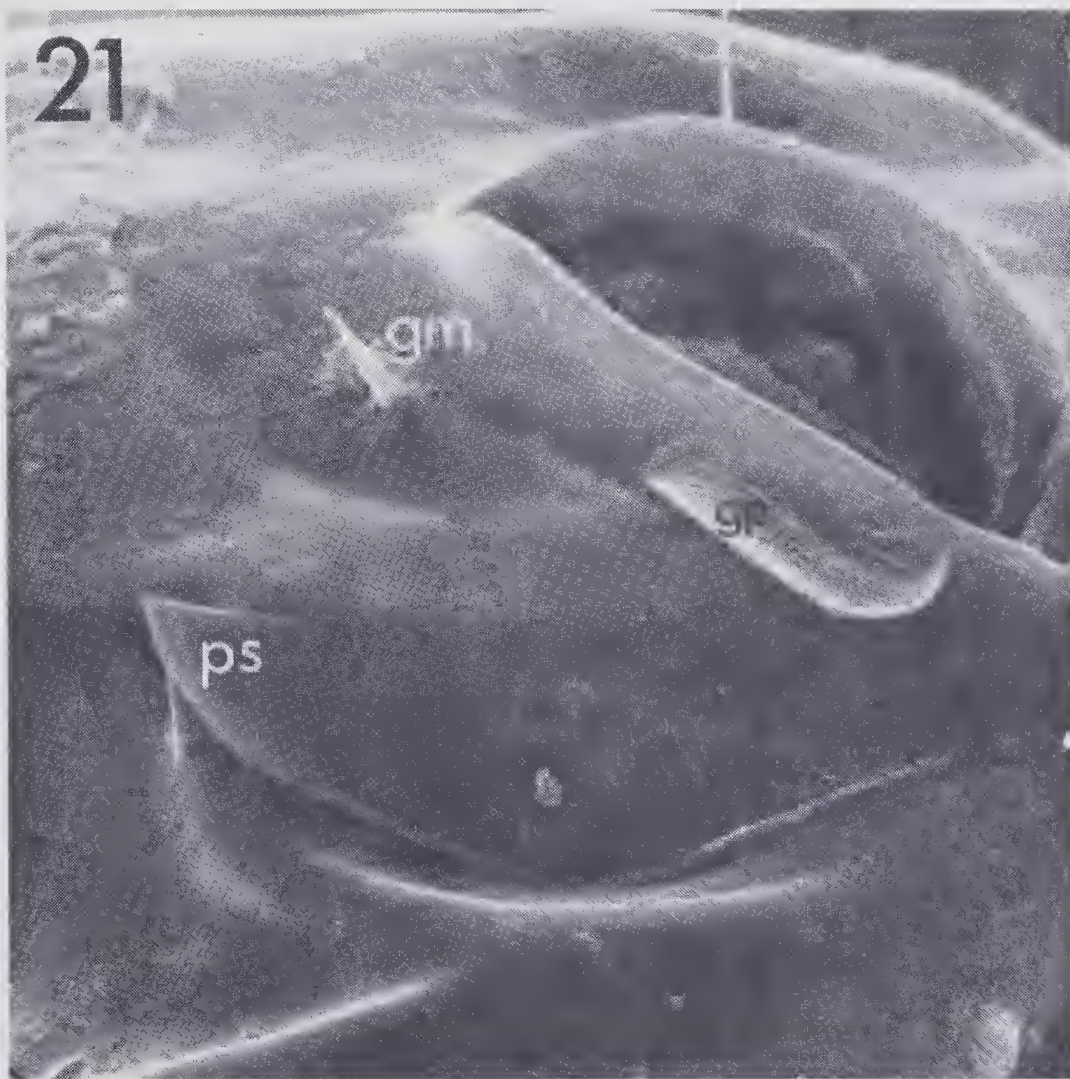


Fig. 21: Scanning picture of genital region of *Marsupipus zyzomys* hypopus showing perigenital sclerite with lateral spur (*ps*) and adhesive disc-like genital posterior seta (*gp*). (For meaning of symbols see text.)

Rock-rats of genus *Zyzomys* are known to have very fragile tails. Walker (1964) stated, 'Many of the specimens have lost part of their tails, which would indicate that the terminal section is brittle and breaks easily.' Ride (1970), based on field experiences, could give more details: 'Although other rats and mice lose their tails with ease if they are maltreated, the hair and flesh strip from the vertebrae of rock-rats particularly easily; the animal soon amputates the remaining naked skeleton to leave a shortened stump'. Our investigations show clearly that degeneration of tail tissues, caused by the

hypopi, results in loss of tail skin. Thus, we may not regard these hypopi as phoretic, using the host for transportation to habitats favourable for further development and reproduction, as suggested in the title of the monograph by Fain (1969). They are real temporary parasites with distinct pathological action. Fig. 18, obtained by courtesy of D. Kitchener, Perth, compares thin tail of young rat (a), older subadult rat with still entire tail (b), young rat with partly lost skin (c) and adult rat with thick tail stump (d).

## LIFE CYCLE

Investigations of more than 100 hosts and morphological characteristics of age allow some remarks on biology and life cycle of mites. Adults of these rock-rats are easily recognized, because they have thick tails rather like those of some species of Australian marsupials and representatives of different mammal orders in deserts in various parts of the world. Juveniles are thin-tailed.

Hypopi were found in larger numbers in thin-tailed females only, few in thin-tailed males; they are absent in thick-tailed adult rats. After being pressed out of follicles and stimulated by cold-shock, hypopi develop within three days to tritonymphs and in a further four days to adults, if humidity and temperature are suitable.

Compared with studied life cycles of *Lophioglyphys liciosus* Lukoschus *et al.*, 1972 (= *Apodemopus apodemi* Fain, 1965), *Marsupialichus marsupialis* Fain *et al.*, 1972 and *Baloghella melis* Lukoschus *et al.*, 1971 (= *Melesodectes auricularis* Fain & Lukoschus, 1968), we may suggest that during reproduction period of hosts hypopi leave the follicles and develop quickly within the host's nest. Free hypopi enter follicles of nestlings and remain there until gravidity. They do not enter follicles of old mice. In nature, stimulation for further development of hypopi is probably given by hormonal changes in host during gravidity and lactation. Environmental factors during dry period in Kimberley region restrict surviving possibilities to hypopial stage, which is protected by body temperature and humidity of surrounding tissues of host. Although we did not succeed in rearing larvae, protonymphs, and free hypopi, we suggest a life cycle with a very long hypopial stage during the dry season, and a shorter period of free living stages in the nests of hosts during the wet season used for reproduction and infection of the next host generation. The well-developed chelicerae indicate that adults feed normally on organic debris in the nests. Presence of adults and homoiomorph developmental stages only during a short period in the



wet season in the hidden nests of hosts may explain why the free living stages of the subfamily have not yet been found and described.

### Systematic Position of the Genus *Marsupiopus* Fain, 1968

The genus *Marsupiopus* Fain, 1968 has been described from hypopial forms. According to the characters of the adult specimens obtained from the rearing of hypopi, it appears that this genus belongs to the family Glycyphagidae. This genus is distinguished from all the known genera in the Glycyphagidae by the following characteristics:

- 1 Cuticular ornamentation consisting of very small elevations with rounded apices.
- 2 Shape of supracoxal seta, which is thick, densely barbed and not branched.
- 3 Grandjean's organ with bifid hairy end.
- 4 Small length of tarsi, especially the anterior tarsi.
- 5 Absence of  $\omega$  2.
- 6 The very small development of the setae *d* 2 and *d* 3.

Some of these characteristics, especially the small length of the tarsi, distinguish this genus from all the other genera in the Glycyphagidae. We think, therefore, that the subfamily Marsupiopinae Fain, 1968, which had been created to accommodate the genus *Marsupiopus*, should provisionally be retained until more material becomes available for comparative study.

### Deposition of Types

Holotype and figured specimens in Western Australian Museum, Perth. Paratypes (hypopi and tritonymphs) in: Perth; Field Museum of Natural History, Chicago; U.S. National Museum of Natural History, Washington, D.C.; The Acarology Laboratory, Columbus, Ohio; British Museum (Natural History), London; Muséum National d'Histoire Naturelle, Paris; Institute of Parasitology, Prague; Zoologisches Museum, Hamburg; Forschungsinstitut Senckenberg, Frankfurt; B.P. Bishop Museum, Honolulu; Institut de Médecine Tropicale Prince Léopold, Antwerp; Zoologisch Laboratorium, Nijmegen.

### *MARSUPIOPUS ANTECHINUS* FAIN & LUKOSCHUS, 1976

The species has been described from *Antechinus flavipes* from Wandanian and from a host of unknown locality.

From an alcohol preserved *Sminthopsis granulipes* Troughton, 1932, Lake Grace, W.A., 10 March 1973, K. Youngson, WAM coll. no. M10205, hypopi

have been collected from hair follicles of tail, which fit in most characteristics and measurements to description. There are some small differences: the second thin setae on tibiae I and II are only  $8\ \mu$  long, while they are  $14\ \mu$  in specimens from typical host; claws of legs I and II are longer ( $12\ \mu$ ) than in typical series (9); scapular setae are arranged on transverse rank; perigenital ring is smaller (54 wide, 42 long) than in typical series (60, 54).

Although we know that small morphological differences in hypopi from different host species and widely separated geographical regions may be of systematical importance and hypopi may give rise to very different adults like in *Lophioglyphus liciosus* Volgin, 1964 and *L. japonensis* Lukoschus *et al.*, 1977, we will not separate them until adults are known from both host species.

Deposition of specimens as in previous species.

*MARSUPIOPUS LEPORILLI PSEUDOMYS*  
FAIN & LUKOSCHUS, 1976

Subspecies has been collected from *Pseudomys hermannsburgensis* (Waite, 1896) from Hermannsburg and *Rattus fuscipes* (Waterhouse, 1839) from unknown locality.

From *Sminthopsis murina* (Waterhouse, 1838), Beacon, W.A., 29 August 1975, collected by K. Youngson, host in WAM coll. no. M12607, hypopi have been collected from tail hair follicles, which fit the characteristics and measurements of typical series with exception of longer *v i*  $16\ \mu$  ( $13\ \mu$  in typical series) and shorter  $17\ \mu$  solenidion *phi* II ( $23\ \mu$  in typical series).

Deposition of specimens as in *M. zyzomys*.

ACKNOWLEDGEMENTS

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PARASITES OF WESTERN AUSTRALIA  
V  
NASAL MITES FROM BATS (ACARI: GASTRONYSSIDAE  
AND EREYNETIDAE) (1)

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ABSTRACT

Two species of parasitic mites have been observed in nasal cavities of flying foxes: *Opsonyssus asiaticus* Fain, 1959 in *Pteropus alecto* and *P. scapulatus* (new host records) and *Neospeleognathopsis* (*Pteropignathus*) *pteropus* n. sp. from *P. scapulatus*, the latter representing a new subgenus of *Neospeleognathopsis*.

INTRODUCTION

In the nasal cavities of bats from Western Australia, the junior author collected two species of mites belonging to the family Gastronyssidae (Order Astigmata), and Ereynetidae (Order Prostigmata). One of these is a new species and is described here.

FAMILY GASTRONYSSIDAE Fain, 1956  
SUBFAMILY RODHAINYSSINAE Fain, 1964  
Genus *Opsonyssus* Fain, 1959  
*Opsonyssus asiaticus* Fain, 1959

This species has been described from the nasal cavities of *Pteropus giganteus* (Brünn) and of *Pteropus melanopogon* Peters, both from unknown localities.

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In Western Australia we found a small series of specimens of that species in two new hosts:

- 1 *Pteropus alecto* Temminck, 1825, from Brooking Springs, 8.X.1976 (bat no. 2969) (one male and one female specimen).
- 2 *Pteropus scapulatus* Peters, 1862, from Geikie Gorge, 6.X.1976 (bat no. 2947) (five females and two males).

FAMILY EREYNETIDAE Oudemans, 1931

SUBFAMILY SPELEOGNATINAE Womersley, 1936

Genus *Neospeleognathopsis* Fain, 1958

Subgenus *Pteropignathus* subg. nov.

This new subgenus differs from the type subgenus (type species *N. chiropteri*) by the following characters: absence of propodosomal scutum, presence of a pair of intercoxal I setae (*i c 1*), anterior situation of the *v i* setae which are in front of the *v e* setae, sensillae slightly inflated basally. Other characters as in the type subgenus, except for minor differences (see Fain 1970 and Fain and Lukoschus 1971).

Type species: *Neospeleognathopsis (Pteropignathus) pteropus* sp. nov.

*Neospeleognathopsis (Pteropignathus) pteropus* sp. nov.

Female (Fig. 1): Idiosoma in the holotype 390  $\mu$  long and 255  $\mu$  maximum width. Dorsum: the *v i* setae are foliate and situated in front of the *v e* setae. Sensillae slightly inflated in their basal half, they are 30-35  $\mu$  long. Hysterosomal setae as in *N. chiropteri*. Venter: coxal setae (I to IV): 2-1-2(1)-1. The *i c 1* are present. There are 4 pairs of genital setae, and two pairs of anal setae. Gnathosoma: there is 1 pair of ventral setae. Palps: tarsus with 4 setae and 1 solenidion, tibia with one large dorsal seta. Chaetotaxy of the legs (I-IV): Trochanters 1-1-0-0. Femora 6-4-3-2. Genus 4-4-3-3. Tibiae 5-3-3-3. Tarsi 12-8-7-7.

Male: Allotype 395  $\mu$  long and 245  $\mu$  wide. General aspect as in the female but the genital slit is shorter, there are only 3 pairs of genital setae, some setae of tarsus and genu I are much longer and there is a broad bilobed testicule.

Larva: Idiosoma 375  $\mu$  long, 200  $\mu$  wide (specimen strongly flattened). Chaetotaxy of propodosoma as in the female. Coxal setae 2-1-1. Gnathosoma: there is one pair of ventral setae. Palps of two segments. All the legs with a pair of small normally formed and equal claws.

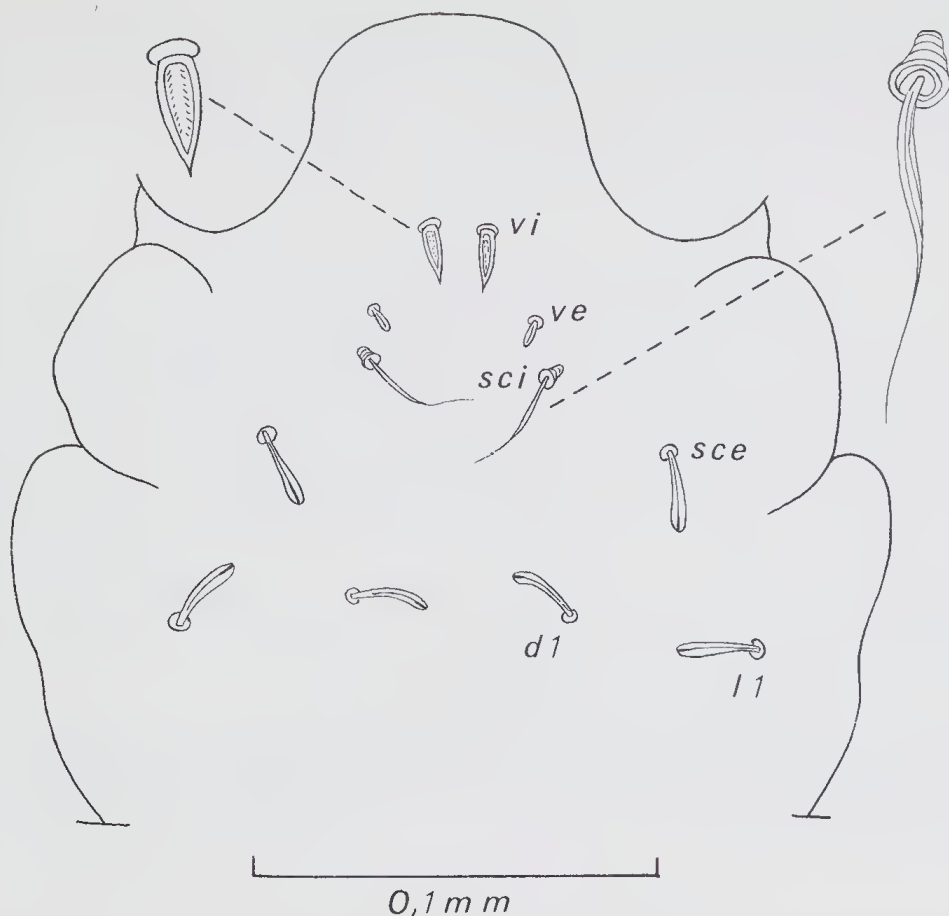


Fig. 1: *Neospeleognathopsis (Pteropignathus) pteropus* sp. nov. Female holotype: dorsal surface of propodosoma.

### Host and locality

In the nasal cavities of *Pteropus scapulatus*, Brooking Springs, 7.X.1976 (bat no. 2952) (holotype and 5 paratypes female, allotype male, 7 larvae or larval skins). Types in the Western Australian Museum, Perth. Paratypes in collections of Field Museum of Natural History, Chicago; Institute of Tropical Medicine, Antwerp, Belgium; and Department of Zoology, Catholic University of Nijmegen, The Netherlands.

### ACKNOWLEDGEMENTS

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## PARASITES OF WESTERN AUSTRALIA

### VI

## MYOBIIDAE PARASITIC ON BATS (ACARINA: PROSTIGMATA)

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and

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### ABSTRACT

Mites of the family Myobiidae were studied in Australia by Womersley (1941), Domrow (1955, 1963, 1973), Fain (1973, 1974, 1976), and Fain and Lukoschus (1976). They are fur-mites confined to four orders of mammals: marsupials, insectivores, bats and rodents. In the present paper we deal with the species from bats in Australia, especially Western Australia.

Womersley (1941) described four species from South Australian bats: *Myobia miniopteris* from *Miniopterus schreibersi* and *Chalinolobus gouldii*; *Myobia clara* from unidentified bats; *Myobia minima* and *Myobia chalinolobus*, both from *Chalinolobus gouldii*.

Dusbabek (1973) redescribed the holotype of *M. chalinolobus* and transferred it to *Pteracarus*.

In the present paper we describe 8 new species and 2 new subspecies.

### INTRODUCTION

During the Western Australia Field Programme 1976-1977, F.S.L. collected numerous myobiids on various bats from Western Australia. These comprise 15 species belonging to 8 genera, of which 8 species and 2 subspecies are new.

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Through the courtesy of Mr D.C. Lee, Curator of Arachnids, South Australian Museum, Adelaide, we could also examine the type series of the Myobiidae from bats described by Womersley, and other material. This contains a male labelled *Neomyobia clara* (Wom.) but the specimen is in fact a new species described below.

The length of the body includes the gnathosoma, the width is maximum.

The holotypes and allotypes of new species described below from Western Australia are deposited in the Western Australian Museum, Perth and paratypes in the Field Museum of Natural History, Chicago, Institute of Tropical Medicine, Antwerp, Belgium, and Department of Zoology, Catholic University of Nijmegen, The Netherlands.

The bats of the Kimberley expedition were identified by Dr Darrell Kitchener, Curator of Mammals, Western Australian Museum, Perth. They are in the collection of the Field Museum of Natural History, Chicago.

### GENUS *ACANTHOPHTHIRIUS* PERKINS, 1925

Fain (1972a, 1972b, 1976a and 1976b) divided *Acanthophtirius* into 4 subgenera according to the characters of the males. It is represented in Australia by *Acanthophtirius* s.s. and *Myotimyobia* Fain, 1972.

*Acanthophtirius* s.l. contains 34 species, of which 17 belong in *Myotimyobia*. The typical subgenus contains 9 species including the three new ones described below.

A key of the males of *Myotimyobia* was given by Fain & Whitaker (1976). We give below a key of the males of *Acanthophtirius* s.s.

### KEY TO SUBGENUS *ACANTHOPHTHIRIUS* (MALES ONLY)

(Male of *A. poppei* Trouessart, 1895 not seen)

- 1 Setae *d* 1 and *d* 2 subequal, 90-100  $\mu$  long
  - ... .. *A. etheldredae* Perkins, 1925
  - Seta *d* 2 from 2,5 to 3 times longer than *d* 1
  - ... .. 2
- 2 Seta *ic* 2 strong and very long (at least 200  $\mu$ )
  - ... .. 3
  - Seta *ic* 2 thin and not longer than 60  $\mu$
  - ... .. 5

- 3 External seta of coxa II a strong spine. Seta *ic* 4  
120  $\mu$  long  
... .. *A. womersleyi* sp. nov.  
External seta of coxa II short and very thin.  
Seta *ic* 4 thin and very short ... .. 4
- 4 Seta *ic* 2 regularly attenuated  
... .. *A. plecotius* (Radford, 1938)  
Seta *ic* 2 with base strongly inflated and spindle-  
shaped  
... .. *A. bohemicus* (Dusbabek, 1963)
- 5 Seta *ic* 4 very thick and barbed; seta coxal IV  
very thick and long, situated very laterally, far  
from *ic* 4. External seta of coxa II thin  
... .. *A. noctulius* (Radford, 1938)  
Seta *ic* 4 thin, not barbed; seta coxal IV thin  
and short, close to *ic* 4. External seta of coxa  
II strongly spinous  
... .. 6
- 6 Setae *ic* 2 to *ic* 4 strong and equal or subequal  
(60-65  $\mu$ ). Femur and genu III with 2 or 3  
strong, short spines  
... .. *A. acinipus* sp. nov.  
Seta *ic* 3 very thin and shorter (15-20  $\mu$ ) than  
*ic* 2 (30  $\mu$ ) and *ic* 4 (80  $\mu$ ), femur and genu III  
with 1 spine  
... .. *A. intercalatus* sp. nov.

1 *ACANTHOPHTHIRIUS CLARUS* (WOMERSLEY, 1941)

*MYOBIA CLARA* WOMERSLEY, 1941: 53

*RADFORDIA CLARA* RADFORD, 1951: 272

*ACANTHOPHTHIRIUS CLARUS* DUSBABEK, 1969: 552

This species is known only from females from unidentified bats from South Australia. In the absence of males it is not possible to determine its subgenus.

We have examined a female labelled: '*Neomyobia clara* (Wom. 1941). Ty. On bats M 499, 4418-31 Loc. S.A.'.

As Womersley did not designate a holotype we select this specimen as the lectotype.

Lectotype (Figs 1-3): 438  $\mu$  long (gnathosoma included) and 177  $\mu$  wide maximum. Dorsum: Most dorsal setae foliate-striate and finely attenuated apically. Setae *vi*, *sci*, *sce* and  $\ell 1$  66  $\mu$ , 96  $\mu$ , 140  $\mu$  and 150  $\mu$  long respectively. Setae *d4* and  $\ell 3$  63  $\mu$  and 57  $\mu$  long. Setae  $\ell 4$  thin, at least 36  $\mu$  long (broken at apex). Vulvar lobes relatively small. Venter: Coxal setae 2-3-0-1. Setae *ic1* very small. Setae *ic2* strong, 70-80  $\mu$  long, *ic2* 60  $\mu$  apart. Setae *ic3* approximately as wide and as long as *ic2*, *ic3* 66  $\mu$  apart. Setae *ic4* a little thinner but longer (90  $\mu$ ) than *ic2* and *ic3*, *ic4* 78  $\mu$  apart. Coxal seta IV about 30  $\mu$  long. Setae *g2* (internal) situated on same line as the *g1* (external); *g1* 30  $\mu$ , *g2* 18  $\mu$  long. Halfway between *g1-g2* and *ic4* is a pair of rounded sclerites 41  $\mu$  apart.

Chaetotaxy of legs II-IV: Trochanters 3-3-3. Femora 5-3-3. Genua 7-6-6. Most of these hairs unusually long; dorsal seta of trochanter III is 30  $\mu$  long, representing approximately 1,5 times length of corresponding genu.

#### Systematic position of *A. clarus*

The separation of the species of *Acanthophtirius* is difficult in the absence of males, but *A. clarus* seems to be distinguished by the combination of following characters: setae *ic2*, *ic3* and *ic4* long (70 to 90  $\mu$ ); seta *ic3* closer to midline than to lateral border of body: setae *g1* and *g2* situated on a straight line; *g1* (external) approximately twice as long as *g2*; two opisthogastric sclerites rounded, equally distant from setae *ic4* and *g1-g2*, and separated by 41  $\mu$ ; dorsal seta of trochanter II and coxal seta IV 30  $\mu$  long; seta *sce* distinctly longer (140  $\mu$ ) than *sci* seta (96  $\mu$ ).

#### Host and locality

On unidentified bats from South Australia. Lectotype in South Australian Museum, Adelaide.

## 2 ACANTHOPHTHIRIUS (ACANTHOPHTHIRIUS)

### WOMERSLEYI SP. NOV.

In the series of mites sent to us by the Curator of the South Australian Museum, Adelaide, we found one slide containing a male and labelled as

follows: '*Neomyobia clara* (Wom.) ♂, det. H. Womersley. *Miniopterus gouldi* Warbla cave, Nullabor, S. Aust. Jan. 1961 (coll. Aitken, H. Mincham)'.

This specimen belongs to the typical subgenus of the genus *Acanthophthirius* by most of the characters. It is, however, clearly distinct from the 5 other species known in that subgenus. We do not think that it represents the male of *A. clarus* (Wom.) mainly because the size of this specimen is much larger than the holotype of *A. clarus*. In all the known species of the genus *Acanthophthirius* the male is always distinctly smaller than the female. We assume therefore that this male belongs to a new so far undescribed species. We describe here that new species and give it the name *A. womersleyi*, from the late Australian acarologist H. Womersley.

Male (Figs 4-5, 33): Holotype 540  $\mu$  long and 255  $\mu$  maximum wide. Dorsum: setae *ve* 24  $\mu$  wide in its anterior part and strongly attenuated posteriorly, 150  $\mu$  long. Setae *sci*, *sce* and *l1* 84  $\mu$ , 180  $\mu$  and 195  $\mu$  long respectively. Genital sclerite very slightly asymmetric, bearing 4 pairs of small setae. Setae *d2* much longer (135  $\mu$ ) than *d1* (54  $\mu$ ). Penis thin, 165  $\mu$  long. Venter: seta *ic2* with a short and very thick, asymmetrical base, and a very long narrow apical part, its total length is 200  $\mu$ . Seta *ic3* thin and short (20  $\mu$ ). Seta *ic4* 120  $\mu$  long. Distance *ic2-ic2* 15 to 20  $\mu$ . Coxal setae (II to IV): 2-3-0-1. External seta of coxa II is a strong spine 30  $\mu$ . Cuticle strongly produced laterally between legs III and IV, forming a verrucous lobe recurved ventrally. Leg I ending in a pair of small claws. Legs II and III thicker than legs IV; leg II with one strong claw (45  $\mu$  long) and one very small claw (12  $\mu$  long); leg III bearing an anterior very strong claw, 45  $\mu$  long, and a posterior smaller and 30  $\mu$  long. Leg IV with two thinner and subequal claws. Trochanter and femur I with a strong spine. Femur and genu III bearing each a strong conical spine and a wider flattened denticulate spine. These strong flattened spines are not observed in the other species of the subgenus *Acanthophthirius*.

#### Host and locality

On *Miniopterus gouldi*, Warbla Cave, Nullarbor, South Australia, January 1961. There is only one species of bat in Australia with the name *gouldii*, it is *Chalinolobus gouldii*. The true host of this mite should be therefore either a *Miniopterus* sp. or *Chalinolobus gouldii*.

Holotype in the South Australian Museum, Adelaide.

### 3 ACANTHOPHTHIRIUS (ACANTHOPHTHIRIUS)

#### ACINIPUS SP. NOV.

The male of this species presents the main characters of the typical subgenus, e.g. the presence of a big spine on anterior surface of both trochanter and femur II, the great inequality of claws II and the production of the cuticle laterally between legs III and IV. However all the legs are relatively narrow and by this character it is closer to the subgenus *Myotimyobia*.

Male (Figs 6-7, 35): Holotype 480  $\mu$  long and 213  $\mu$  wide. Dorsum: genital orifice slightly asymmetrical, a little in front of setae  $\ell$  1. Penis 135  $\mu$  long. Setae  $d$  1 and  $d$  2 54  $\mu$  and 150  $\mu$  long respectively. Setae  $\ell$  1 186  $\mu$  long. The 3 pairs of posterior setae subequal (21  $\mu$ ). Venter: coxal setae 2-3-0-1. The latero-coxals II are strong spines. Setae  $ic$  2 to  $ic$  4 60  $\mu$ , 60  $\mu$  and 66  $\mu$  respectively.

Chaetotaxy of legs II-IV: Trochanters 3-3-3. Femora 5-3-3. Genua 7-7-6. There are strong spines on trochanter II, on femora II-III, on genua III and IV, and tibiae III-IV.

Female (Figs 8-10): Allotype 558  $\mu$  long and 230  $\mu$  wide. Dorsum: Setae  $u$   $i$ ,  $sci$ ,  $sc$   $e$ ,  $\ell$  1 and  $d$  1 69  $\mu$ , 165  $\mu$ , 105  $\mu$ , 205  $\mu$  and 75  $\mu$  long respectively. Setae  $d$  4,  $\ell$  3 and  $\ell$  4 thin and 60  $\mu$ , 60  $\mu$  and 40  $\mu$  long. Genital lobes large. Venter: Coxal setae 2-3-0-1. Setae  $ic$  2 to  $ic$  4 75  $\mu$ , 105  $\mu$  and 80  $\mu$  long. Setae  $ic$  3 are 78  $\mu$  apart,  $ic$  4 100  $\mu$  apart. Opisthogaster sclerites rounded, 39  $\mu$  apart, they are situated at the same distance (60  $\mu$ ) from the  $g$  2 and the line joining  $ic$  4 setae (63-65  $\mu$ ). Setae  $g$  1 setae longer (33  $\mu$ ) than  $g$  2 (22  $\mu$ ).

Chaetotaxy of the legs II-IV: Same number of setae as in the male, the genua II and III also bear 7 setae.

#### Host and locality

- 1 On *Nycticeius greyi* (Gould, 1858), from Beverley Springs, 19, 20 and 23.IX.1976 (bats no. 2773 and 2797) (Holotype and 1 paratype male, allotype female and 3 paratype nymphs.) Also 14 nymphs and 1 larva (all paratypes) on same host but Beagle Bay, 23.VIII.1976 (bat no. 2612) and 4 nymphs (paratypes) from same host but Mitchell Plateau, 22.X.1976 (bat no. 3076).
- 2 On *Eptesicus pumilus* Gray, 1841, from Beverley Springs, 19.IX.1976 (bat no. 2739) (15 paratype nymphs).



#### 4 *ACANTHOPHTHIRIUS (ACANTHOPHTHIRIUS)*

##### *INTERCALATUS* SP. NOV.

This species is distinguished from *A. (A.) acinipus* sp. nov., in the male by the much smaller length of the *ic* 2 and *ic* 3 setae, the greater length of *ic* 4 and the presence of only one spine on femur and genu III; in the female by the different situation of the opisthogastric sclerites, which are closer to *g* 2 setae (distance 55  $\mu$ ) than to *ic* 4 setae (72  $\mu$ ).

Male (Figs 11-12, 36): Holotype 495  $\mu$  long and 213  $\mu$  wide. Dorsum: Setae *sc i*, *sc e*, *d* 1, *d* 2,  $\ell$  1 105  $\mu$ , 163  $\mu$ , 57  $\mu$  and 195  $\mu$  long respectively. Genital orifice at 15  $\mu$  in front of  $\ell$  1, genital plate almost symmetrical. Penis 120  $\mu$  long. Venter: Setae *ic* 2, *ic* 3 and *ic* 4 30  $\mu$ , 15-20  $\mu$  and 80  $\mu$  long respectively. External seta of coxa II is a strong spine. Legs with strong spines on trochanter II, on femora II and IV, on genua III and tibiae III and IV. Genua II to IV with 7-6-6-setae.

Female (Figs 13-15): Allotype 606  $\mu$  long and 240  $\mu$  wide. Dorsum: Setae *vi* 15  $\mu$  wide. Setae *sc i*, *sc e*, *d* 1,  $\ell$  1, *d* 3  $\ell$  3 and  $\ell$  4 117  $\mu$ , 175  $\mu$ , 90  $\mu$ , 185  $\mu$ , 90  $\mu$ , 66  $\mu$  and 51  $\mu$  long respectively. Cuticle behind the genital lobes finely verrucous. Venter: Setae *ic* 2 to *ic* 3 90  $\mu$ , 96  $\mu$  and 105  $\mu$  long respectively. Distance *ic* 3-*ic* 3 = 87  $\mu$ ; *ic* 4-*ic* 4 = 112  $\mu$ . Opisthogastric sclerites rounded, 40  $\mu$  apart; they are situated at 72  $\mu$  from *ic* 4 and at 55  $\mu$  from *g* 2.

##### Host and locality

On *Nyctophilus arnhemensis* Johnson, 1959, Beverley Springs, 19.IX.1976 (bats no. 2741 and 2742) (Holotype and 3 paratype males, allotype female, 2 paratype nymphs).

#### 5 *ACANTHOPHTHIRIUS (MYOTIMYOBIA) MINIMUS*

##### (WOMERSLEY, 1941) COMB. NOV.

##### *MYOBIA MINIMA* WOMERSLEY, 1941: 55

The holotype and so far only specimen known of this species is not a female as thought by Womersley, but a tritonymph.

This nymph presents the main characters of *Acanthophtirius*. Legs I are symmetrical, legs II have 2 claws, legs III-IV have 1 claw, setae *ic* 2 to *ic* 4 are long, the 2 pairs of coxal II setae are strong striated spines.

We have found on several bats of *Chalinolobus* from Australia and New Guinea adult mites and nymphs of a species of *Acanthophthirius* which correspond very probably to *A. minimus*. We describe here the adults of this species.

Female (Figs 16-18): Body size in 2 specimens from *Chalinolobus gouldii*, from Kangaroo Flats, Melbourne (length x width):  $564\ \mu \times 238\ \mu$  and  $560\ \mu \times 228\ \mu$ . In two specimens from *Chalinolobus nigrogriseus rogersi* these measurements are  $570\ \mu \times 220\ \mu$  and  $561\ \mu \times 216\ \mu$ . The following description is based on a specimen from the typical host. Dorsum: Setae *sc i*, *sc e*, *d 1*, *l 1*, *d 3*, *l 3*, *l 4*  $105\ \mu$ ,  $150\ \mu$ ,  $87\ \mu$ ,  $175\ \mu$ ,  $72\ \mu$ ,  $57\ \mu$ ,  $57\ \mu$  long respectively. Genital lobes large. Venter: *ic 2*, *ic 3* and *ic 4* approximately  $60\ \mu$  long. Setae *ic 3* closer to the median line ( $48\ \mu$ ) than to the lateral margin of body ( $66\ \mu$ ). Setae *ic 4*  $105\ \mu$  apart. Coxal IV seta thin and  $27\ \mu$  long. Setae *g 1* and *g 2* on a convex line; they are subequal in length ( $48\ \mu$ ). Opisthogaster with two large crescentic sclerites about  $60\ \mu$  apart and much closer to *ic 4* ( $30\ \mu$ ) than to *g 2* ( $75\ \mu$ ). Leg setae relatively long and thin.

Male (Figs 19, 20, 32): Our description is based on a specimen from *Chalinolobus nigrogriseus rogersi*. This specimen presents the characters of the subgenus *Myotimyobia*. Body  $387\ \mu$  long and  $159\ \mu$  wide. Dorsum: Setae *sc i* shorter ( $78\ \mu$ ) than *sc e* ( $113\ \mu$ ); *d 1* shorter ( $50\text{--}55\ \mu$ ) than *d 2* ( $75\ \mu$ ). Genital plate enlarged anteriorly with two produced lateral corners, almost symmetrical, ending posteriorly into two subequal triangular projections. Penis rather strong,  $100\ \mu$  long. Venter: Setae *ic 2*, *ic 3* and *ic 4*  $48\ \mu$ ,  $60\ \mu$  and  $60\ \mu$  long. Distance *ic 3*–*ic 3* =  $75\ \mu$ ; distance *ic 4*–*ic 4* =  $80\ \mu$ . All the coxal setae thin. Legs not inflated and without spines; the setae are mainly thin and long, exceptionally slightly spinous.

#### Hosts and localities

- 1 *Chalinolobus gouldii* (Gray, 1841), South Australia (bat no. M401,506) (holotype nymph, in the South Australian Museum, Adelaide). From the same host, from Kangaroo Flats, Melbourne (bat in the collection of British Museum) no. 99.7.4.1 (2 females) (Coll. A. Fain).
- 2 *Chalinolobus gouldii venatoris*, Thomas, 1908 from Alexandria, Northern Territory, Australia (bat no. 7.1.4.5-6 in the British Museum) (1 female) (Coll. A. Fain).
- 3 *Chalinolobus nigrogriseus rogersi* Thomas, 1909, Napier Downs, Western Australia, 20 and 30.VIII.1976 (bats no. 2626, 2763, 2769) (11 females, 10 males, 3 nymphs, 2 larvae) (Coll. F. Lukoschus).



4 *Chalinolobus nigrogriseus* (Gould), New Guinea, bat no. 1970-2001-2005, in the British Museum (1 female) (Coll. A. Fain).

## 6 *ACANTHOPHTHIRIUS (MYOTIMYOBIA) ALATUS* SP. NOV.

This new species is characterized in the male by the presence on the posterodorsal surface of the trochanters III of a membranous triangular lobe directed posteriorly. Such a lobe is absent in all the other known species. Female very close to *A. (M.) intercalatus*.

Male (Figs 21-22, 34): Holotype 405  $\mu$  long and 165  $\mu$  wide. Dorsum: Genital orifice situated at the level of  $\ell$  1; genital sclerite almost symmetrical, bearing 4 pairs of small setae. Penis 110  $\mu$  long; narrow in its distal half. Setae *sc i* shorter (84  $\mu$ ) than the *sc e* (130  $\mu$ ). Setae *d 1* and *d 2* respectively 48  $\mu$  and 135  $\mu$  long. The three posterior pairs of setae are stiff, sub-cylindrical and 18-20  $\mu$  long. Venter: Coxal setae (II-IV) 2-3-0-1. Coxal IV thin and 12  $\mu$  long. Setae *ic 2* to *ic 4* 50  $\mu$ , 55  $\mu$  and 90  $\mu$  long. Distances *ic 3-ic 3* = 59  $\mu$ ; *ic 4-ic 4* = 66  $\mu$ . Legs II to IV not inflated. Claws: Tarsi I with a pair of very small claws; tarsi II with 2 very unequal claws; tarsi III and IV with 2 claws slightly unequal in width. Trochanter III with a triangular membranous lobe on its posterior surface. Chaetotaxy of legs II-IV: Trochanters 3-3-3. Femora 5-3-3. Genua 7-6-6. Tibias 6-6-6. Trochanter and femur I without strong spines and the internal coxal II is not spinous.

Female (Figs 23-25): Allotype 525  $\mu$  long and 210  $\mu$  wide. Dorsum: Dorsal setae relatively thick. Setae *vi* being 14  $\mu$  wide; *vi*, *sc i*, *sc e*,  $\ell$  1 and *d 1* 78  $\mu$ , 84  $\mu$ , 132  $\mu$ , 150  $\mu$  and 75  $\mu$  long respectively. Setae *d 4*,  $\ell$  3 and  $\ell$  4 are thin and 60  $\mu$ , 50  $\mu$  and 38  $\mu$  long respectively. Genital lobes well developed. Venter: Coxal setae as in the male; setae *ic* longer than in the male. Setae *g 2* (internal) a little in front of *g 1* setae, the former being a little shorter than the latter. Opisthogaster sclerites rounded and 36  $\mu$  apart; they are closer to *g 2* setae (42  $\mu$ ) than to *ic 4* setae. Chaetotaxy of the legs: Most of setae thin and long; number of setae as in the male.

### Host and locality

On *Eptesicus douglasi* Kitchener, 1976 from Geikie Gorge. On 4 bats (no. 2916, 2926, 2979, 2980), 4 to 9.X.1976 (Holotype male, allotype and 6 paratypes female, 11 nymphs and 1 larva, all paratypes).

From the same host, from Brooking Springs (bats no. 2893 and 2903), 3.X.1976. (6 nymphs).

## GENUS *Calcarmyobia* RADFORD, 1948

Four species have been described so far in *Calcarmyobia*: *C. rhinolophia* (Radford, 1940) (the type species), *C. miniopteris* (Womersley, 1941), *C. parenzani* Lombardini, 1956 and *C. japonica* Uchikawa, 1976.

The typical host of *C. rhinolophia* is *Rhinolophus lobatus*, from Kenya. This species has also been recorded from other bats, mainly *Miniopterus schreibersi*, in several countries of Africa and Europe.

*C. miniopteris* has been described from *Miniopterus schreibersi* and *Chalinolobus gouldii* in Australia. Several authors have put this species in synonymy of *C. rhinolophia*.

The typical host of *C. parenzani* is not known. It was an unidentified bat, from a cave, in Italy.

*C. japonica* was described from *Miniopterus schreibersi fuliginosus* in Japan. According to Uchikawa, this species is only separable with certainty from *C. rhinolophia* by the characters of the genital plate and the dorsal chaetotaxy of the male.

The junior author collected on *Miniopterus schreibersi* from Western Australia, males and females that agree perfectly with the description and the figures of *C. japonica*. Through the courtesy of Dr Uchikawa we were able to examine a male and a female of that species collected on the typical host in Japan, and to confirm the original description. From these findings it appears that in Japan and in Australia, and probably in other countries of East Asia, the bat *Miniopterus schreibersi* harbors a species of *Calcarmyobia* that is distinct from the true *C. rhinolophia*. This species has been named *C. miniopteris* by Womersley in 1941. According to the law of priority, the name *C. japonica* Uchikawa published in 1976 is a junior synonym of the former (Figs 43-45).

Recently, Dr Domrow sent to the senior author a male and two females labelled '*Calcarmyobia rhinolophia*'. These mites were collected on *Miniopterus australis*, from Queensland. The male agrees with *C. miniopteris* except that the genital plate is shorter and that the *d* 2 and the *g p* are slightly thicker than in that species. It is therefore more or less intermediate between *C. miniopteris* and *C. rhinolophia*, however closer to the former. In the two females the *d* 3, *d* 4 and *ℓ* 2 have a longer posterior narrow part than in both *C. miniopteris* and *C. rhinolophia*. These specimens could represent a new form of *C. miniopteris* (Figs 46-48, 51).

TABLE 1

Main characters of the males of *Calcaromyobia rhinolophia* and *C. miniopteris* from different hosts and countries (in microns)

Specimen	<i>C. rhinolophia</i> (Figs 37-42)			<i>C. miniopteris</i> (= <i>C. japonica</i> ) (Figs 43-48)		
	Type male	1 male	1 male	1 male	2 males	1 male
Host of specimens	<i>Rhinolophus lobatus</i>	<i>Miniopterus schreibersi</i>	<i>Miniopterus schreibersi</i>	<i>Miniopterus schreibersi</i>	<i>Miniopterus schreibersi</i>	<i>Miniopterus australis</i>
Origin of specimens	Kenya	Czechoslovakia	Poland	Japan	W. Australia	Queensland
Length of setae						
<i>vi</i>	165	147	150	120	110-120	108
<i>sci</i>	82	78	75	60-63	58-63	60-63
<i>d1</i>	15	22	19	18	18	15
<i>d2</i>	48	33	30	25	25-30	30-33
<i>l2</i>	45	45	40	57	65-75	56
<i>gp</i>	7-7,5	6	5	12-13	13-15	15
Maximum width of setae						
<i>d2</i>	4,5-5	4	6	2	1,8-2	3-3,2
<i>l2</i>	4,5-5	6	5	7,2	7-7,5	6-7
<i>gp</i>	2	0,5	0,5	2,5	3,6-4,5	5-6
Presence of <i>ga</i> setae	small	large	large	?	?	?
Genital plate:						
maximum length	51	50	-	56	54	42
maximum width	36	40	-	38	38	42

Moreover, the male specimens of *Calcarmyobia* found so far in Europe on *Miniopterus schreibersi* and attributed to *C. rhinolophia* by several authors differ from the typical material, as well as from *C. miniopterus*, by the chaetotaxy, mainly the setae of the genital area. In these specimens setae *d 2* shorter and not attenuated apically, *g a* larger and *g p* much thinner. Besides, other setae differ slightly in shape, i.e. *v i* not punctate in their posterior membranous part and *sc i* shorter and their posterior membranous part shorter (Figs 40-42). Should these characters receive a specific importance, then the species inadequately described by Lombardini (*C. parenzani*) might probably become valid as representing the populations parasiting *Miniopterus schreibersi* in Europe.

We have summarized in Table 1 the main characters which separate the males of *C. rhinolophia* from those of *C. miniopterus*.

1 *CALCARMYOBIA MINIOPTERIS* (WOMERSLEY, 1941)

*MYOBIA MINIOPTERIS* WOMERSLEY, 1941: 52

*CALCARMYOBIA JAPONICA* UCHIKAWA, 1976: 56 syn. nov.

This species has been described from South Australia from two different hosts: *Miniopterus schreibersi* Kuhl, 1819 (typical host) and *Chalinolobus gouldii*. Only female specimens were known.

In Western Australia we found it on the typical host from Mitchell Plateau. The specimens were collected from 3 different bats: no. 3003, 17.X.1976 (2 females and 5 nymphs); no. 3021, 19.X.1976 (5 females, 2 males and 7 nymphs); no. 3026, 20.X.1976 (3 nymphs).

The specimens described as *Calcarmyobia japonica* were collected from *Miniopterus schreibersi fuliginosus*, in a cave in Miyazaki Prefecture, Kyushu, Japan.

We give here drawings of the genital area and of setae *v i* and *sc i* in the males and of *d 3*, *d 4* and *ℓ 2* of the females of the following specimens: the type of *C. rhinolophia* (Radford) (Figs 37-39, 49); 1 specimen from *Miniopterus schreibersi* from Kashiwazaki, Niigata Prefecture, Japan (labelled *C. japonica*) (kindly sent by Dr Uchikawa) (Figs 43-45, 50); 1 specimen from *Miniopterus australis*, sent by Dr R. Domrow (Figs 46-48, 51).

## GENUS *HIPPOSIDEROBIA* DUSBABEK, 1968

The genus *Hipposiderobia* contains, so far, 7 species, all parasitic on Hipposideridae.

We describe here a new species discovered on *Rhinonictoris aurantius*, from Western Australia.

### 1 *HIPPOSIDEROBIA BELLI* SP. NOV.

This new species is distinguished by the structure of the *ic* 2 to *ic* 4 setae in the female which are stronger and from 2 to 3 times longer (13 to 18  $\mu$ ) than in all other known species.

This mite is named after Mr Cameron Bell, Brooking Springs Station, who helped us considerably during our expedition.

Female (Figs 52-53): Holotype 290  $\mu$  long and 180  $\mu$  wide. Dorsum: Setae *d* 1 are much thicker and longer (29  $\mu$ ) than the *d* 2 and the  $\ell$  2 which are very thin and short (4 to 6  $\mu$ ); setae *d* 3 situated at 45  $\mu$  behind the  $\ell$  2; the *sc e* and the  $\ell$  1 are 78  $\mu$  and 75  $\mu$  long respectively. Venter: Setae *ic* 1, *ic* 2, *ic* 3 and *ic* 4 relatively thick at their base and 15  $\mu$ , 18  $\mu$ , 16  $\mu$  and 13  $\mu$  long respectively. Coxal setae: 2-3-0-0. Internal pair of coxa II very short (3  $\mu$ ). Chaetotaxy of the legs (II-IV): Trochanters 3-3-3. Femora 5-2-2. Genua 6-5-5. Tibiae 6-5-5. Tarsi 6-3-3.

Male (Figs 31, 54-55): Allotype 222  $\mu$  long and 138  $\mu$  wide. Dorsum: Genital orifice at the level of setae *sc e*. Genital sclerite bearing 5 pairs of minute spinelets. Seta *d* 1 close to the genital sclerite and short (5  $\mu$  long). Penis 100  $\mu$  long, straight. Venter: Setae *ic* 1 to *ic* 4 as in the female but a little shorter. Gnathosoma 42  $\mu$  long (dorsally), relatively narrow. Chaetotaxy of the legs II-IV: As in the female.

### Host and locality

From *Rhinonictoris aurantius* Gray, 1845, from Geikie Gorge, 29.IX.1976, bat no. 2839 (1 female paratype); 3.X.1976 (bat no. 2897) (1 nymph); 8.X.1976, bats no. 2965 (holotype female, allotype and 1 paratype male) and no. 2976 (1 female paratype, 3 male paratypes, 4 nymph paratypes, 1 egg).

The mites have been found in the poorly hairy regions of the wing membrane, in front of the fore legs, with all the legs attached to the wing membrane and not to the hairs.



## GENUS *EWINGANA* RADFORD, 1952

### SUBGENUS *EWINGANA* RADFORD, 1952

The genus name *Ewingana* was created by Radford in 1948, with *E. bispinosa* Radford, 1948 as type species. However Radford did not give a description of the latter and therefore both the genus and the species were *nomina nuda*. Both names are, however, made available by Radford in his paper of 1952. They should therefore be cited with the date 1952 (R.V. Melville, in litt.).

#### 1 *EWINGANA (EWINGANA) BISPINOSA* RADFORD, 1952

*Ewingana (E.) bispinosa* Radford, 1952 has been described from *Tadarida cistura* (= *Nyctinomus cisturus*), from Uganda. Only the female (Fig. 56) has been described.

We have collected on *Tadarida jobensis*, in Western Australia, a series of mites including females and males. The females agree very closely with the species of Radford. The males, however, show several differences with male specimens of *E. bispinosa* collected by the senior author from Central Africa on several *Tadarida* spp. We think therefore that the Australian specimens belong to a new subspecies of *E. bispinosa* which we describe hereunder.

#### *EWINGANA (EWINGANA) BISPINOSA* SSP. *LONGISPINA* SUBSP. NOV.

Male (Fig. 57): Holotype 480  $\mu$  long and 195  $\mu$  wide. Dorsum: Setae *vi* relatively thick and 45  $\mu$  long; *sci* thin, 20  $\mu$  long. Genital orifice at 15  $\mu$  in front of the  $\ell$  1 setae. There are 4 genital spines: two anterior 18  $\mu$  long and two posterior paramedian and unequal; one is slightly thicker and longer (100  $\mu$ ) than the other (80  $\mu$ ). *d* 1, *d* 2,  $\ell$  2 and *d* 3 are thick and 36  $\mu$ , 36  $\mu$ , 90-100  $\mu$  and 75  $\mu$  long respectively. In specimens of *E. bispinosa* from Central Africa these measurements are the following: two posterior paramedian genital spines 66  $\mu$  and 32  $\mu$  long; the *d* 1, *d* 2,  $\ell$  2 and *d* 3 are 29  $\mu$ , 36  $\mu$ , 72  $\mu$  and 85  $\mu$  long. Penis extremely thin and twisted in its apical two-thirds, its total length about 200-225  $\mu$  long. There is a small bare (non striated) area between the *d* 3 and the *d* 4 setae. Setae *d* 4, *d* 5 and  $\ell$  4 are 45  $\mu$ , 40  $\mu$  and 40  $\mu$  long respectively. Venter: Coxal setae 2-3-0-1. Setae



*ic* 3 and *ic* 4 are thin and long (respectively 60  $\mu$  and 105  $\mu$ ); setae *ic* 4 shorter (16  $\mu$ ) than the coxal IV seta (27  $\mu$ ). There is a transversally-elongate bare area behind setae *ic* 4; it is 36  $\mu$  long and 75  $\mu$  wide. Legs: Tarsi II with two very unequal claws. Tarsi III-IV with only one long claw. Coxa I distinctly produced laterally.

Female (Fig. 58): Allotype 561  $\mu$  long and 180  $\mu$  wide. Allotype female resembles closely the holotype female of *E. bispinosa* described by Radford and redescribed by Fain (in press).

#### Host and locality

On *Tadarida jobensis* (Miller, 1902), from Mount Hart, 10 to 28.IX.1977 (bats no. 2623, 2685, 2687, 2688, 2692, 2696, 2701, 2704 and 2711) (holotype and 9 paratype males, allotype and 4 paratype females, 4 paratypes immature).

### GENUS *UGANDOBI*A DUSBABEK, 1968

The genus *Ugandobia* consisted so far of 3 subgenera: *Ugandobia* Dusbabek, 1968, *Embamyobia* Fain, 1972 and *Expletobia* Dusbabek & Lukoschus, 1971. We think now that *Embamyobia* is a synonym of the typical subgenus and that *Expletobia* should become an independent genus. *Ugandobia* comprised, until now, 8 species, from which 5 have been described from Emballonuridae: only one species is known from a Hipposideridae and one from a Pteropidae.

We describe here a new species from an Emballonuridae in Western Australia.

#### 1 *UGANDOBI*A *AUSTRALIENSIS* SP. NOV.

This new species is represented by only males and immatures. The male is distinguished from those of *U. barnleyi* (Radford), *U. emballonurae* Fain and *U. ituriensis* Fain, by the much greater length of setae *ic* 2 to *ic* 4. In *U. euthrix* Fain these setae are also long but this species is distinguished from our new species by the larger size of the body, the aspect of the *sc i* setae, very short and thin, the much smaller length of the dorsal seta of trochanter IV, the thinner aspect of *vi* (7,5 wide), the greater length of the penis.

Male (Figs 29, 59-60): Holotype 370  $\mu$  long and 150  $\mu$  wide. Dorsum: Genital orifice situated at 22  $\mu$  behind the *sc i* setae; there are 5 pairs of genital setae. Penis with 2 curves, 200  $\mu$  long. Setae *d 1* toothed, inflated basally and 26  $\mu$  long. Setae *d 2* 45  $\mu$  long, situated 25  $\mu$  in front of *l 1*. Opisthonotum with 3 pairs of strong setae 22 to 28  $\mu$  long. Venter: Setae *ic 1* to *ic 4* 30  $\mu$ , 60  $\mu$ , 65  $\mu$  and 72  $\mu$  long respectively. Coxal setae: 2-3-0-1. Legs: Trochanter I with laterally a medium-sized triangular prolongation. Chaetotaxy of legs (II-IV): Trochanters 3-3-3. Femora 5-2-2. Genua and tibiae 6-6-6. Tarsi 7-6-6. Most of these setae are long and thin; dorsal seta of trochanter IV 36  $\mu$  long.

#### Host and locality

On *Taphozous flaviventris* Peters, 1867, from Beverley Springs, 18.IX.1976, bat no. 2724 (holotype and 4 paratype males, 5 paratype nymphs).

#### GENUS *PTERACARUS* JAMESON & CHOW, 1952

This genus has been revised by Dusbabek (1973). This author records two species from Australia: *Pteracarus chalinolobus* (Womersley) and *Pteracarus* sp.

1 *PTERACARUS CHALINOLOBUS* (WOMERSLEY, 1941)

*MYOBIA CHALINOLOBUS* WOMERSLEY, 1941: 55

*RADFORDIA CHALINOLOBUS* RADFORD, 1951: 273

*PTERACARUS CHALINOLOBUS* JAMESON & CHOW, 1952:

218 (part.) DUSBABEK, 1973: 250

*PTERACARUS* SP. A., DUSBABEK, 1973: 283

Dusbabek (1973) has redescribed the holotype female of this species collected on *Chalinolobus gouldi* from South Australia. The holotype is deposited in the collection of the South Australian Museum, Adelaide.

In Western Australia we found on three different hosts, numerous female specimens of *Pteracarus* which agree with the holotype female that we have examined. Moreover our male specimens agree with the male from an unidentified host that Womersley had identified as belonging to the same species (*Pteracarus* sp. A. of Dusbabek).

We describe here the male of *P. chalinolobus*, so far not described.

Male (Figs 26, 61-62): We describe here a specimen from *Chalinolobus gouldi*. Body 235  $\mu$  long and 130  $\mu$  wide. Dorsum: Lengths of *vi*, *sc e* and *l 1* are 63  $\mu$ , 93  $\mu$  and 100  $\mu$ . Setae *ve* very short, *sci* very thin and 7  $\mu$  long. Genital area with 3 pairs of very short and thin anterior setae and 2 pairs of longer subequal posterior setae. Setae *d 1* toothed and shorter (8 to 8,5  $\mu$ ) than *d 2* (20  $\mu$ ) which is not toothed. Setae *l 3* are 7-8  $\mu$  long. Venter: Setae *ic 1* very thin and 30-35  $\mu$  long, *ic 2* 45  $\mu$ , *ic 3* 60  $\mu$  and *ic 4* 12  $\mu$ . Gnathosoma: 30-33  $\mu$  wide and 25  $\mu$  long ventrally. Chaetotaxy of the legs II-IV: Trochanters 3-3-3. Femora 5-3-3. Genua 7-6-6. Tibiae 6-6-6. Tarsi 7-6-6.

### Hosts and localities

- 1 *Chalinolobus gouldii*, South Australia (bat no. M401,506) (holotype female). From the same host, from Beagle Bay, W. Australia, 25.VIII.1976 (bat no. 2616) (1 male and 6 females) (Coll. F. Lukoschus).
- 2 *Chalinolobus nigrogriseus rogersi*, from Beverley Springs, W. Australia, 28.VIII to 23.IX.1976 (bats no. 2621, 2622, 2649, 2762, 2763, 2765, 2771 and 2789) (8 females and 2 nymphs).
- 3 *Nycticeius greyi*, from Beverley Springs, 21.IX.1976 (bat no. 2781) (4 males), and from Beagle Bay, 23.VIII.1976 (bat no. 2612) (2 males and 3 nymphs).
- 4 *Eptesicus pumilus*, from Beverley Springs, 19-21.IX.1976 (bats no. 2739 and 2740) (4 females, 2 males, 11 nymphs).
- 5 *Eptesicus douglasi*, from Geikie Gorge, 4 to 9.X.1976 (bats no. 2911, 2915, 2916, 2926, 2931, 2979 and 2980) (20 males, 12 females, 60 immatures); from Brooking Springs, 3.X.1976 (bats no. 2893 and 2903) (8 males, 8 females and 5 nymphs); from Beverley Springs, 19.IX.1976 (bat no. 2745) (2 males).
- 6 (?) *Nycticeius greyi*, from Mitchell Plateau, 22.X.1976 (bat no. 3076) (3 immatures).
- 7 A male specimen identified by Womersley as *Pteracarus chalinolobus* from an unidentified bat, Adelaide, 26.2.60.

The mites collected in Western Australia were located on the wing membrane; the adults were attached with their legs to the skin and not to the hair.

## 2 *PTERACARUS MICRODORSALIS* SP. NOV.

This new species is distinguished from *P. chalinolobus* in the female by the very small size of *d* 1, *d* 2 and *d* 3; in the male by the greater length of *d* 2.

Female (Figs 63-65): Holotype 390  $\mu$  long and 324  $\mu$  wide. Dorsum: Setae *v e*, *sc e* and  $\ell$  1 95-100  $\mu$ , 135  $\mu$  and 140-145  $\mu$  long respectively. Setae *v i* stout rods, 16  $\mu$  long, 26  $\mu$  apart. Setae *sc i* fine, 57  $\mu$  apart. Setae *d* 1 and *d* 2 1 to 2  $\mu$  long, *d* 3 almost vestigial. The  $\ell$  3 and  $\ell$  4 are thick and toothed, 25 and 27  $\mu$  long respectively. Venter: Setae *ic* 1 very thin and 45  $\mu$  long; setae *ic* 2 to *ic* 4 75  $\mu$ , 75  $\mu$  and 21  $\mu$  long. Setae *g* 1 thick and 25  $\mu$  long. Coxal II setae thin. Legs stout, with setae relatively strong. Chaetotaxy of the legs (II-IV): Trochanters 3-3-3. Femora 5-3-3. Genua 7(6)-6-6. Tibiae 6-6-6. Tarsi 7-6-6. Femora II to IV with 1 posterior spine.

Male (Figs 27, 66-67): Allotype 282  $\mu$  long and 160  $\mu$  wide. Dorsum: Setae *v i* and *sc i* very thin and very short. Setae *v e*, *sc e* and  $\ell$  1 80-90  $\mu$ , 110  $\mu$  and 104  $\mu$  long. Genital orifice situated at 30  $\mu$  behind *sc e*. Setae *d* 1 very thin, not toothed and 9  $\mu$  long; setae *d* 2 are stronger, cylindrical and 30  $\mu$  long. Genital plate with 3 pairs of thin and short setae and two pairs of stronger unequal posterior setae. All the coxal setae are thin except coxal IV. Legs as in the female.

### Host and locality

The mites were located on dorsum of tail membrane close to tail base.

- 1 *Nyctophilus* (?), from Beverley Springs, 20.IX.1976 (bats no. 2768 and 2772) (holotype female, allotype male and 2 paratype nymphs).
- 2 *Nyctophilus bifax* Thomas, 1915, from Beagle Bay, 23.VIII.1976 (bat no. 2603) (1 female, 1 male paratype).
- 3 *Nyctophilus arnhemensis* Johnson, 1959, from Beagle Bay, 23.VIII.1976 (bat no. 2611) (1 female, 1 male and 2 immatures, paratypes).

## GENUS *PTEROPIMYOBIA* FAIN, 1973

This genus was represented until now by two species from Asiatic Pteropidae: *P. pahangensis* Fain, from *Macroglossus minimus sobrinus*, of Malaysia, and *P. nyctimene* Fain, from *Nyctimene bougainvillei*, of Bougainville Is. The first species is known only from the female, while in the second both sexes have been described.

We have found on *Macroglossus minimus* a mite that is very close to *P. pahangensis*. It is distinguished from it mainly by the presence of an

accessory tooth on the ventro-internal surface of the tibio tarsus of leg I. We think it therefore necessary to separate in in a new subspecies.

It is to be noted that some mammalogists consider at present that *Macroglossus* is not represented in northern Australia by the species *lagochilus* as thought so far, but by the species *minimus* and that the species which is encountered in Malaysia should correctly be named *M. sobrinus* and not *M. minimus sobrinus*. (Start, pers. comm.)

*PTEROPIMYOBIA PAHANGENSIS* SUBSP.

*QUINQUEDENS* SUBSP. NOV.

Female: Holotype 498  $\mu$  long and 192  $\mu$  wide. Characters as in the typical form except that there are 5 teeth on the ventral surface of tibiotarsus I instead of 4 in the typical form.

Male (Figs 30, 68-69): Allotype 455  $\mu$  long and 180  $\mu$  wide. Dorsum: Genital orifice situated at 9  $\mu$  in front of setae *sc e*. Penis 130  $\mu$  long, straight. Setae *vi* and *sc i* very small. Setae *d 1* and *d 2* subequal, 55-58  $\mu$  long. Venter: Coxals scaly, wide and striate; *ic 1* also in the shape of a scale; *ic 2* and internal coxal II foliate-striate; *ic 3*, *ic 4* and *g 1* as *ic 2*. Leg I as in the female. Genu I with a strong ventral spine 21  $\mu$  long.

Host and locality

On *Macroglossus minimus*, Mitchell Plateau, 19 and 20.X.1976 (bats no. 3013, 3016, 3018, 3019, 3020, 3022, 3023 and 3042) (holotype and 9 paratypes female, allotype and 12 paratypes male, 21 nymphs, larvae or eggs all paratypes).

The adult mites had their legs I embedded into the hair follicle and partly attached to the hair with the lateral prolongation of genu I.

GENUS *BINUNCUS* RADFORD, 1954

1 *BINUNCUS MAGNUS* (RADFORD, 1934)

*MYOBIA MAGNA* RADFORD, 1934: 363

*BINUNCUS MAGNA* RADFORD, 1954: 242; FAIN (in press)

This species has been described from a bat, *Pteropus giganteus* which was kept in captivity in England. Fain (in press) has redescribed and has given new figures of both sexes of that species.



In Australia we have found this species on *Pteropus alecto* Temminck, 1837, from Brooking Springs, 28-29.IX.1976 (bats no. 2805, 2819 and 2822) (31 females, 3 males and 41 nymphs), 1.X.1976 (bat no. 2962) (2 nymphs) and 2.X.1976 (bat no. 2877) (1 larva).

Other specimens, only females and nymphs, have been collected from *Pteropus gouldii*, from Indooroopilly, Queensland, by Domrow (specimens sent to the senior author) and by the senior author from a *Pteropus* sp. bat captured in Australia and preserved in the Institut royal des Sciences naturelles, Brussels, Belgium.

## 2 *BINUNCUS FORTIS* SP. NOV.

This species is distinguished from *B. magnus* in the female by the greater size of the body; in the male mainly by the different structure of the genital area and the different shape and disposition of some dorsal setae.

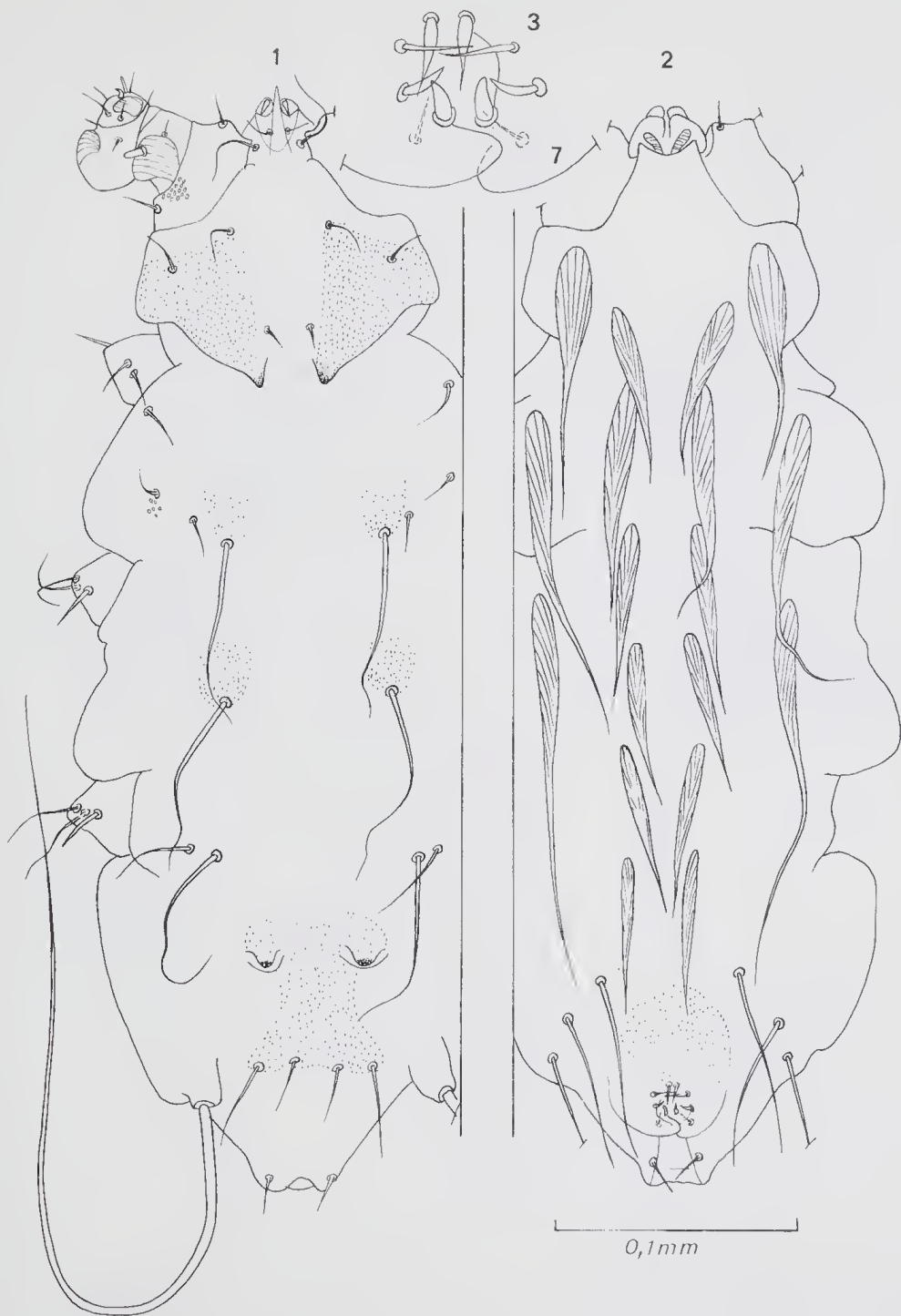
Male (Figs 28, 70-71): Holotype 570  $\mu$  long and 294  $\mu$  wide. Dorsum: Genital aperture at 40  $\mu$  behind the *sc e* setae. The genital plate bears 3 pairs of small anterior spinelets and 2 pairs of posterior thin and short unequal setae; this plate is prolonged posteriorly by a narrow elongate sclerite enlarged basally. Penis thick in its basal part (100  $\mu$  long) and extremely thin apically. Setae *sc i* thick and short. Setae *d 1* and *d 2* subequal (100-105  $\mu$ ). Distance *d 1-d 2* 50  $\mu$ , which is distinctly greater than in *B. magnus*. Venter as in *B. magnus*. The distance *ic 3-ic 3* is 93  $\mu$ ; the distance *ic 4-ic 4* = 66  $\mu$ ; distance coxal IV-coxal IV is 72  $\mu$ . Other characters as in *B. magnus*.

Female (Figs 72-74): Allotype 855  $\mu$  long and 455  $\mu$  wide. General aspect as in *B. magnus*. Dorsum: Setae *sc i*, *sc e*, *d 1*,  $\ell 1$  135  $\mu$ , 230  $\mu$ , 120  $\mu$ , 270  $\mu$  long. Legs II-IV with two long unequal claws, bearing thin setae except tibiae III and IV which carry a strong recurved ventral spine 33 to 39  $\mu$  long. Leg I and gnathosoma as in *B. magnus*.

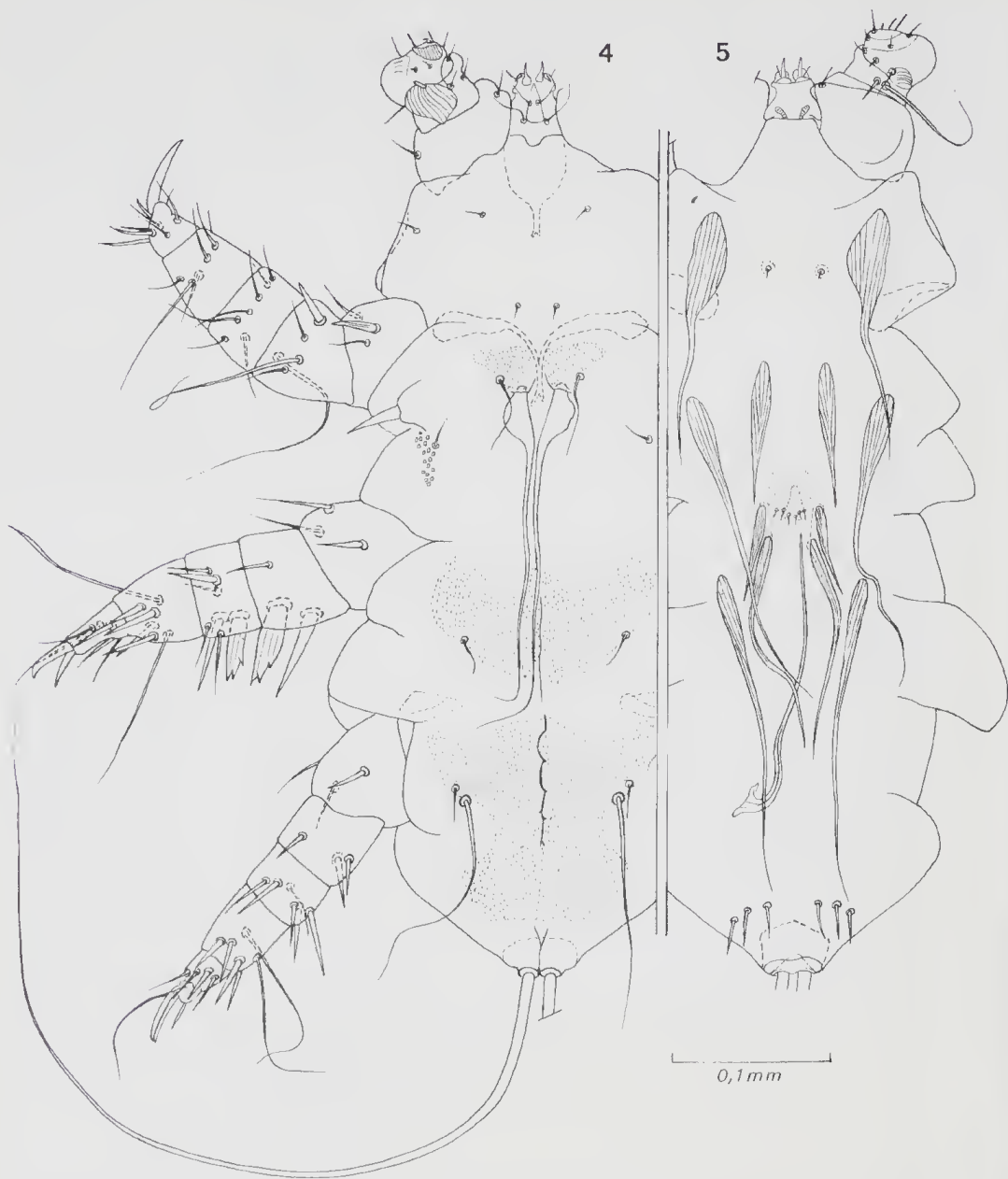
### Host and locality

On *Pteropus scapulatus* Peters, 1862, from Western Australia, from three different localities: Brooking Springs, 1.X.1976 (bat no. 2876) (holotype male, allotype female and 17 paratypes immatures; Napier Downs 31.VIII.1976 (bats no. 2634 and 2636) (1 paratype male and 8 paratypes immatures); Geikie Gorge, 6.X.1976 (bat no. 2952) (2 paratypes nymphs).

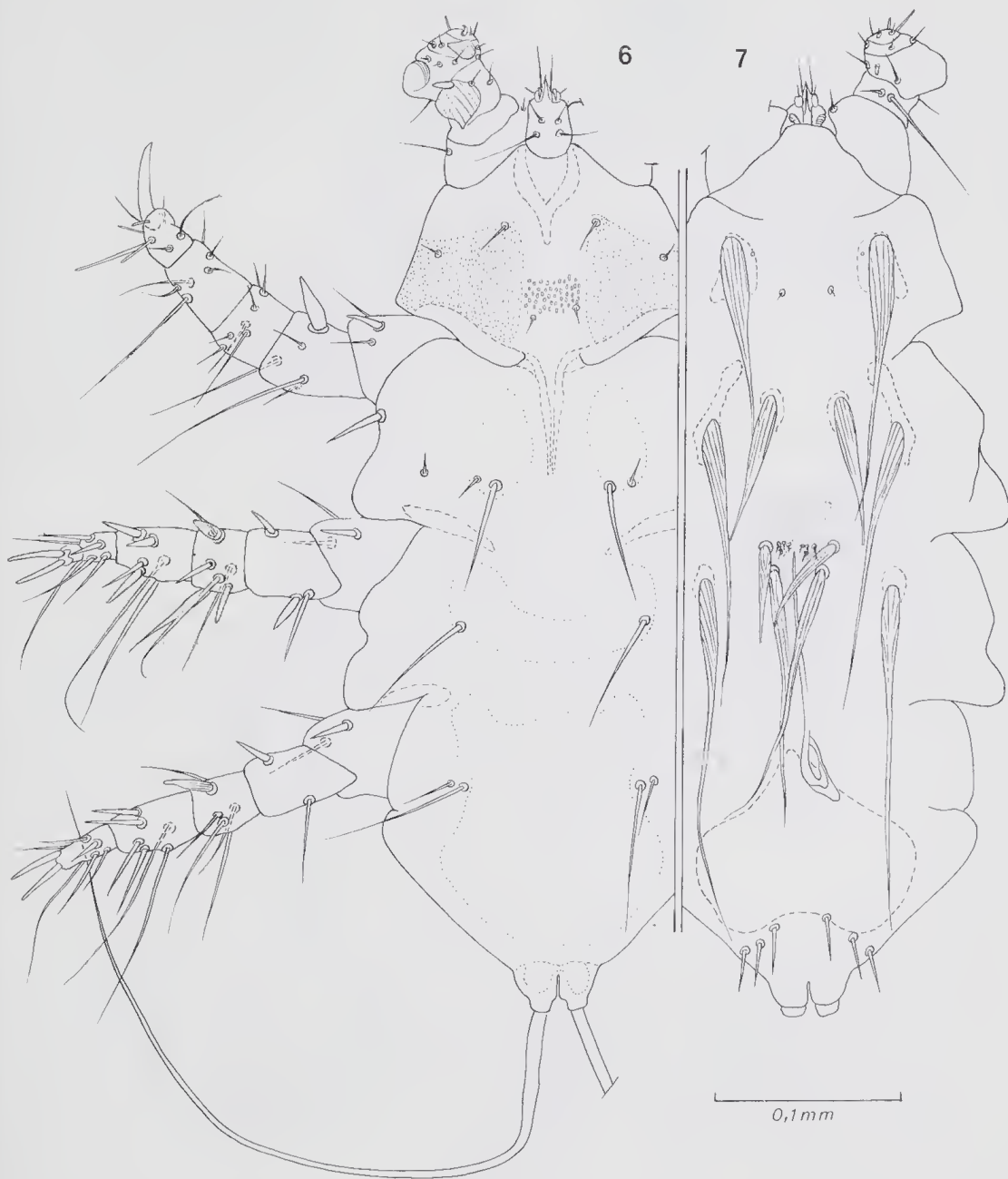




Figs 1-3: *Acanthophthirius clarus* (Wom.). Lectotype female. Fig. 1 — ventral view; Fig. 2 — dorsal view; Fig. 3 — genital area.



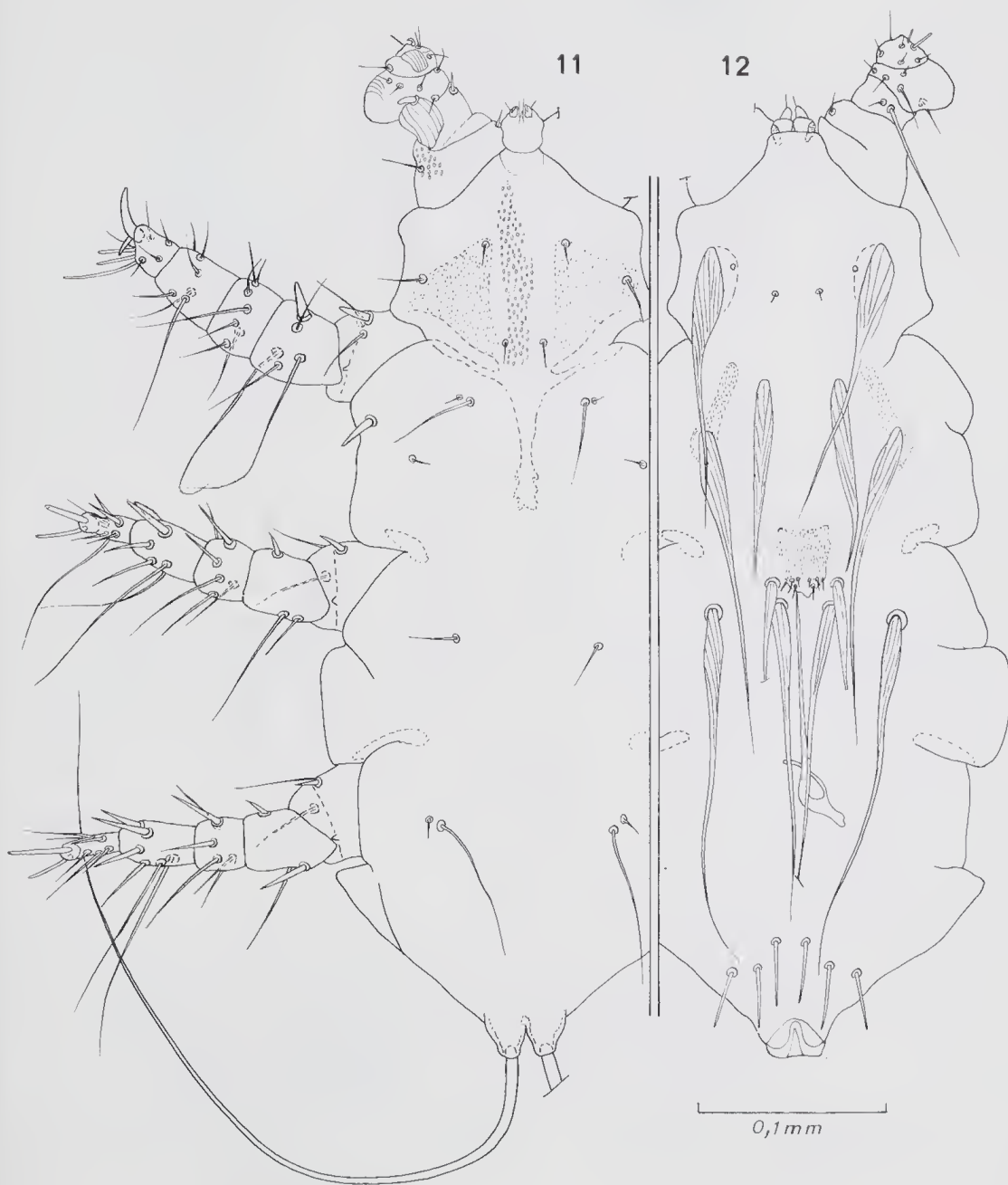
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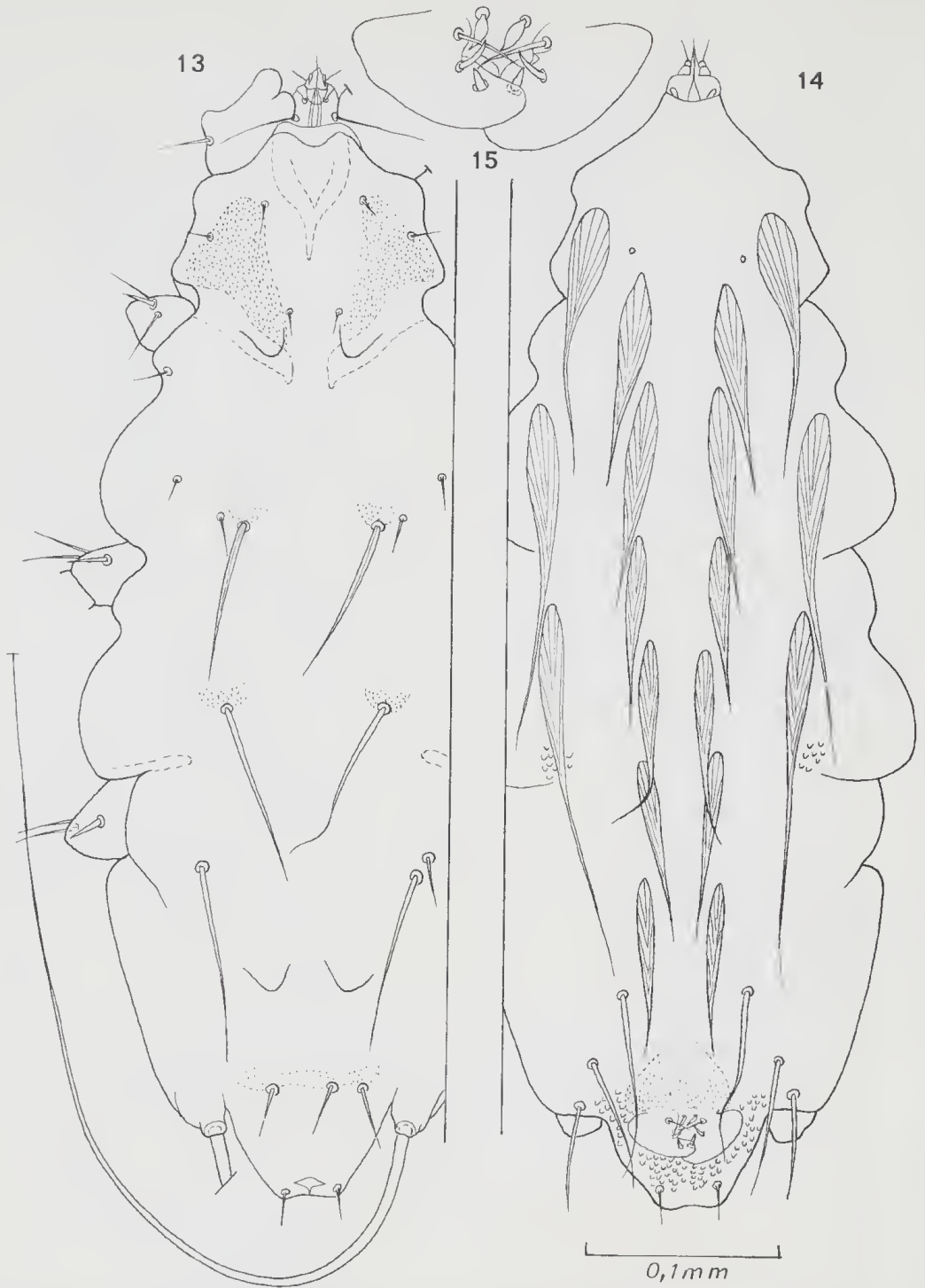
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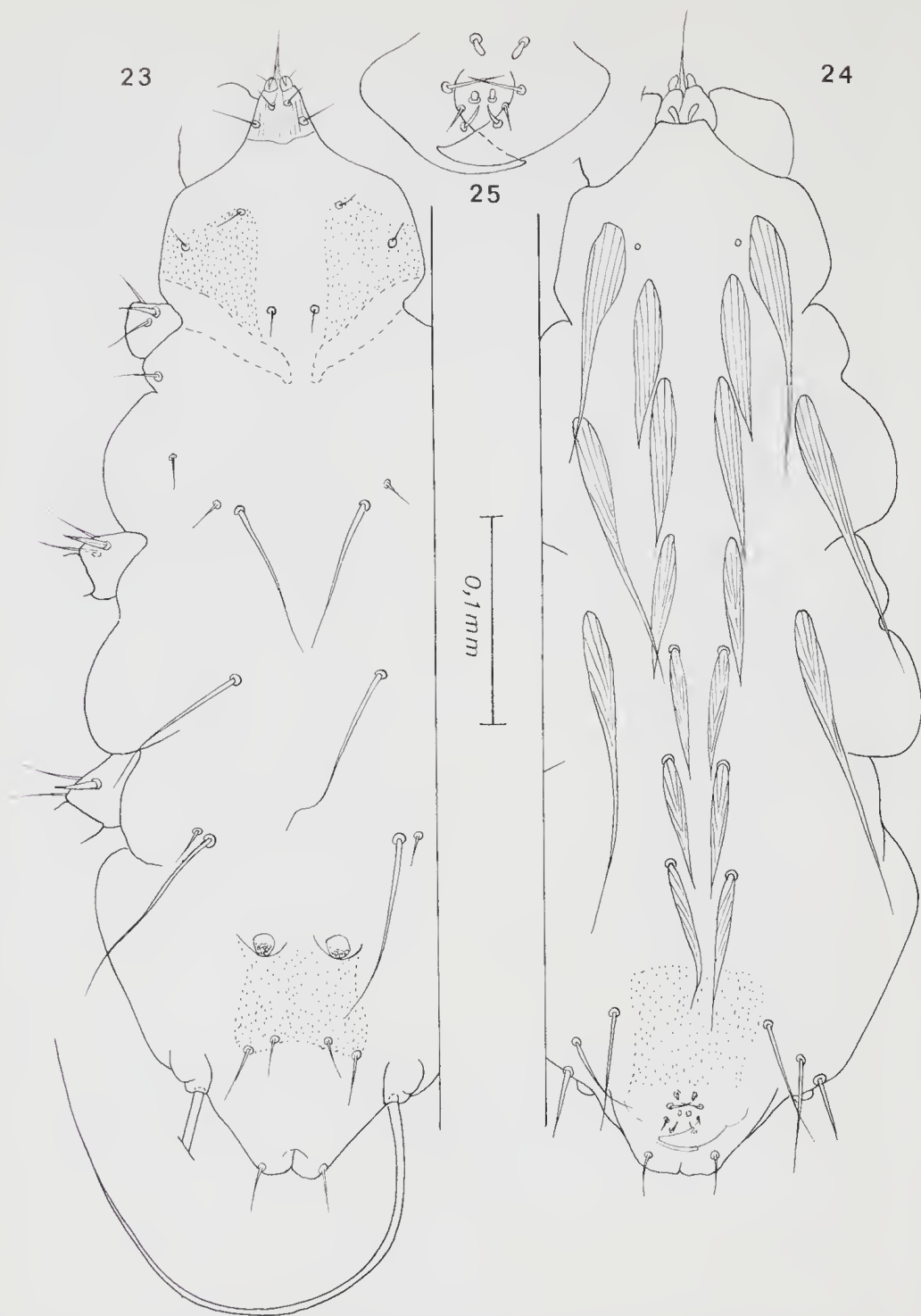
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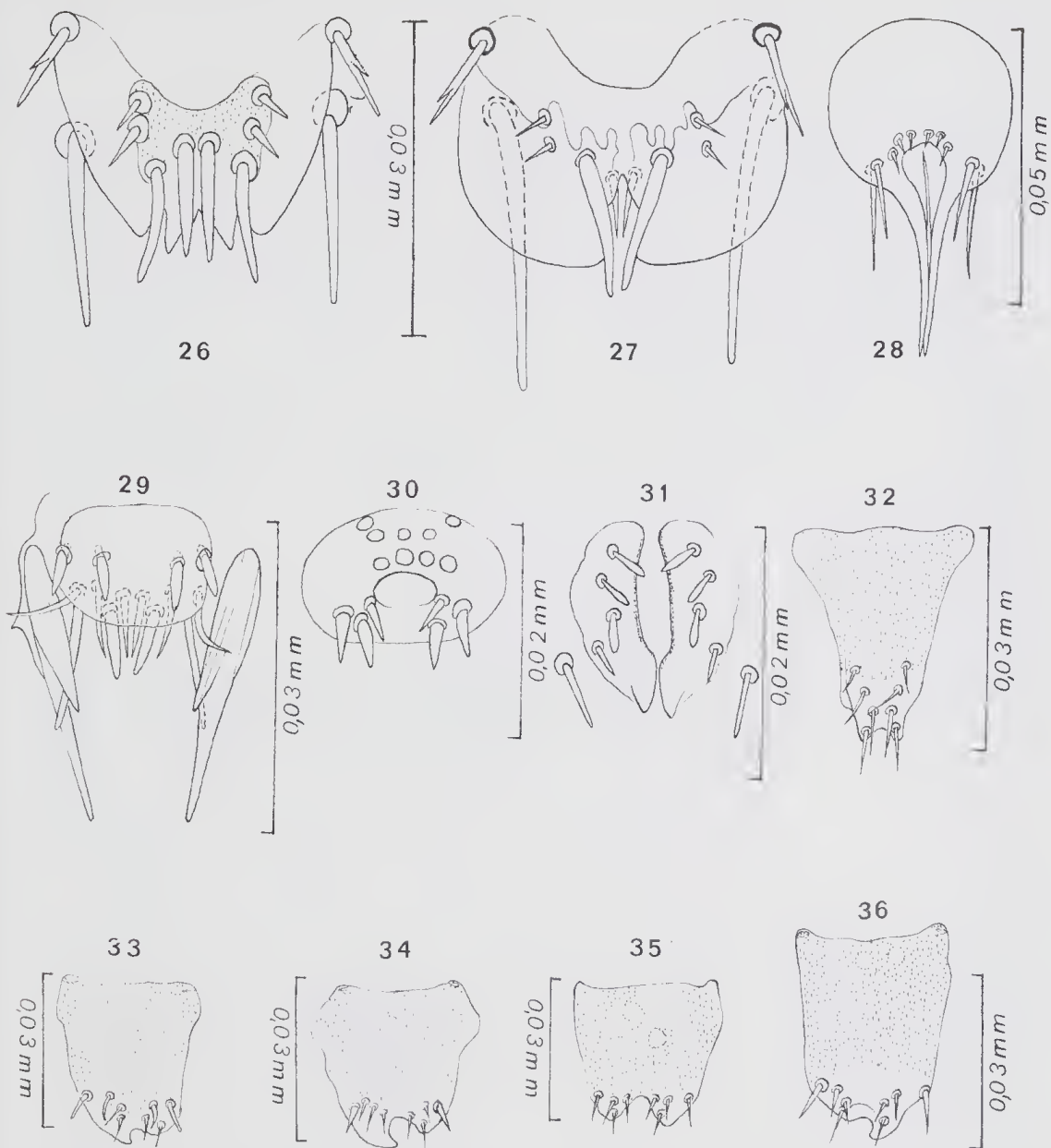
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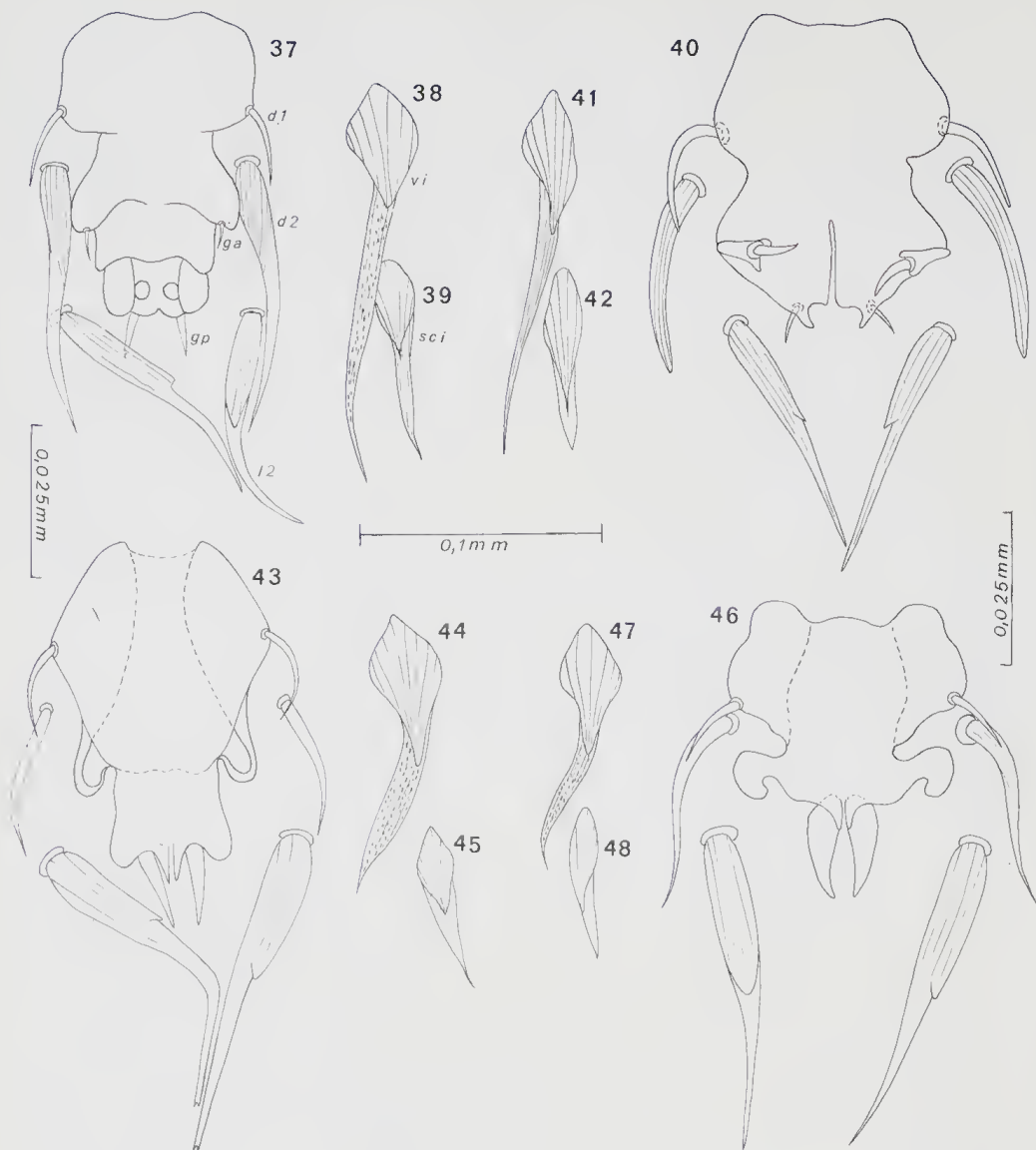
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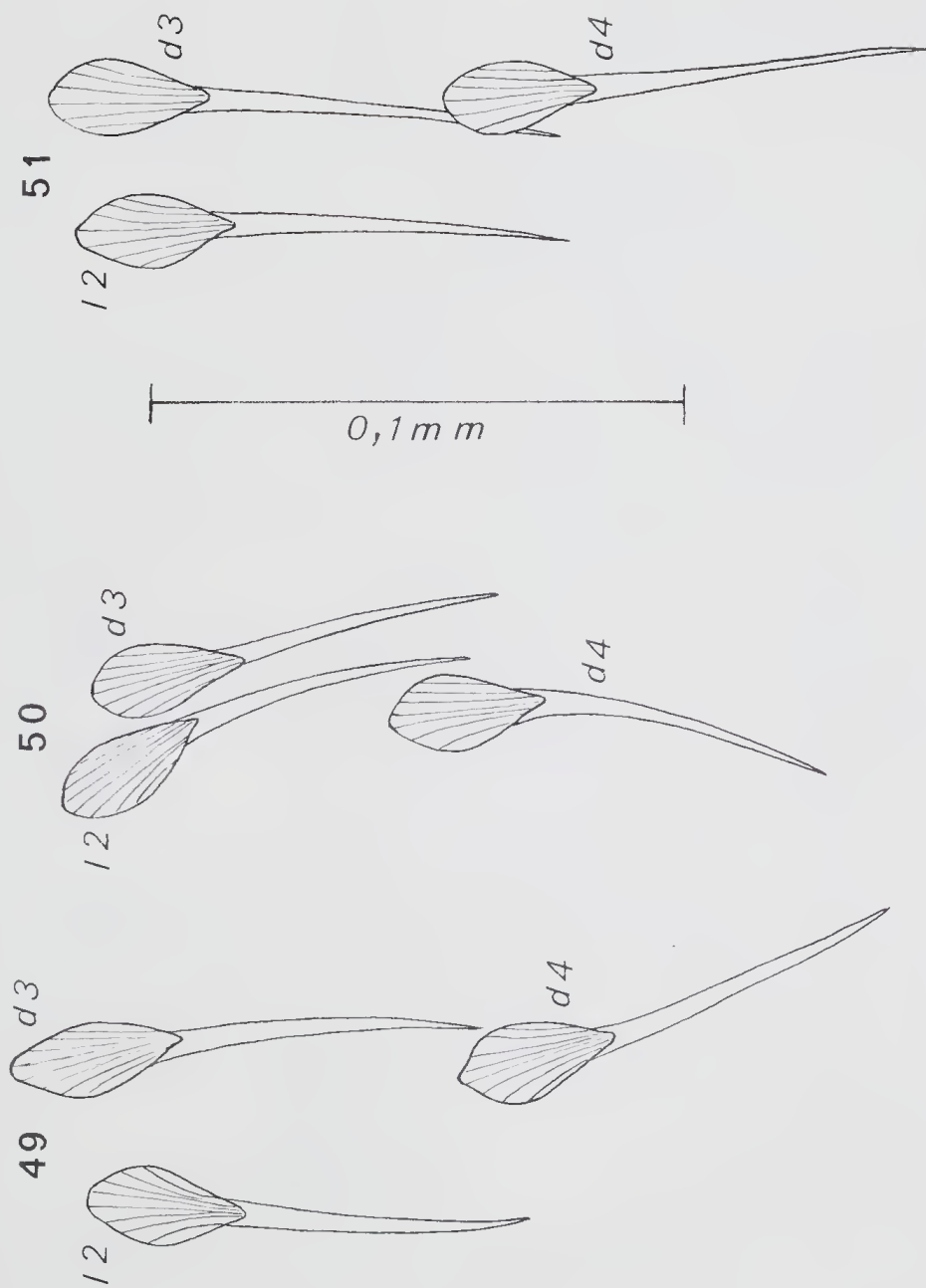
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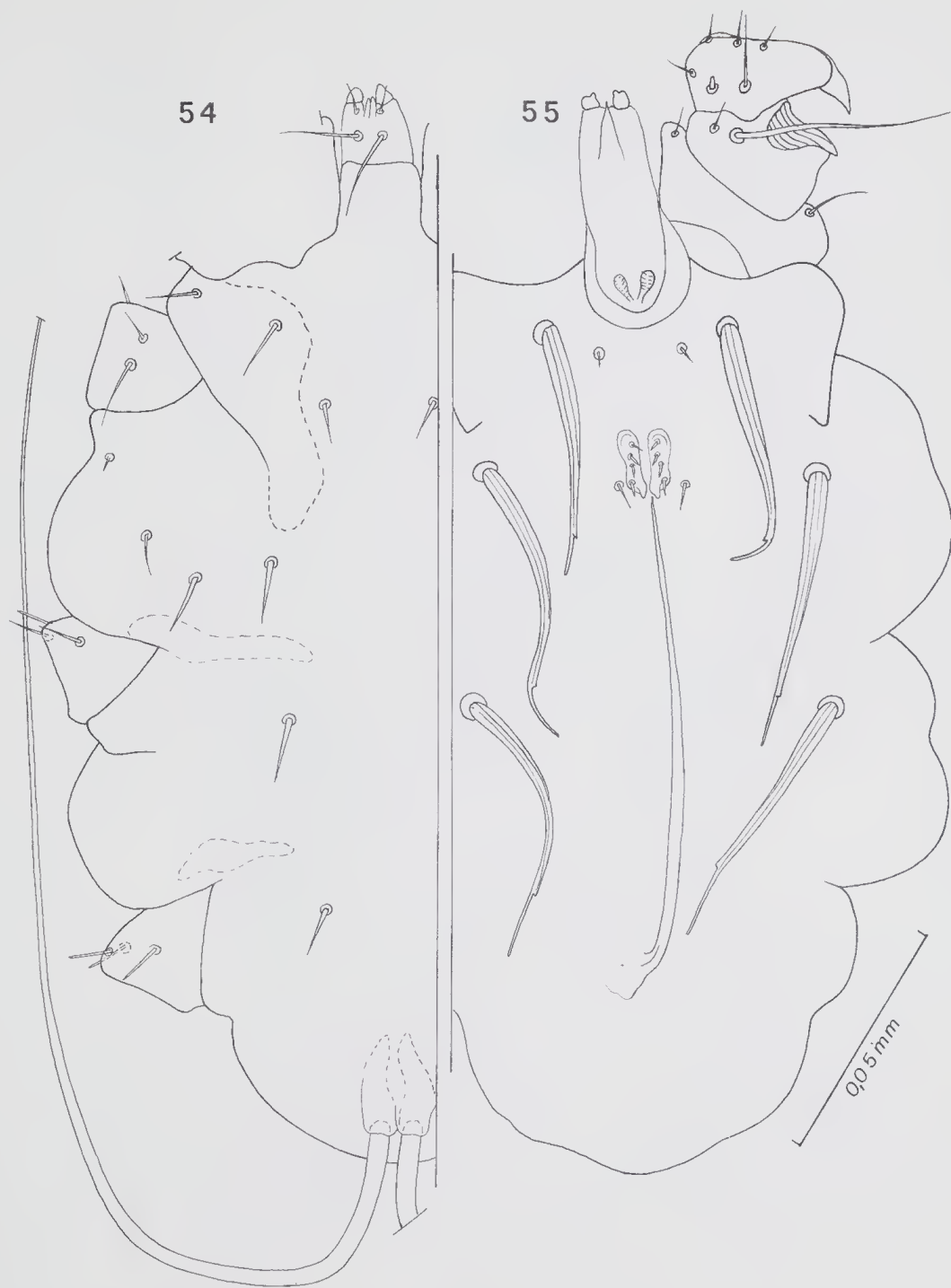




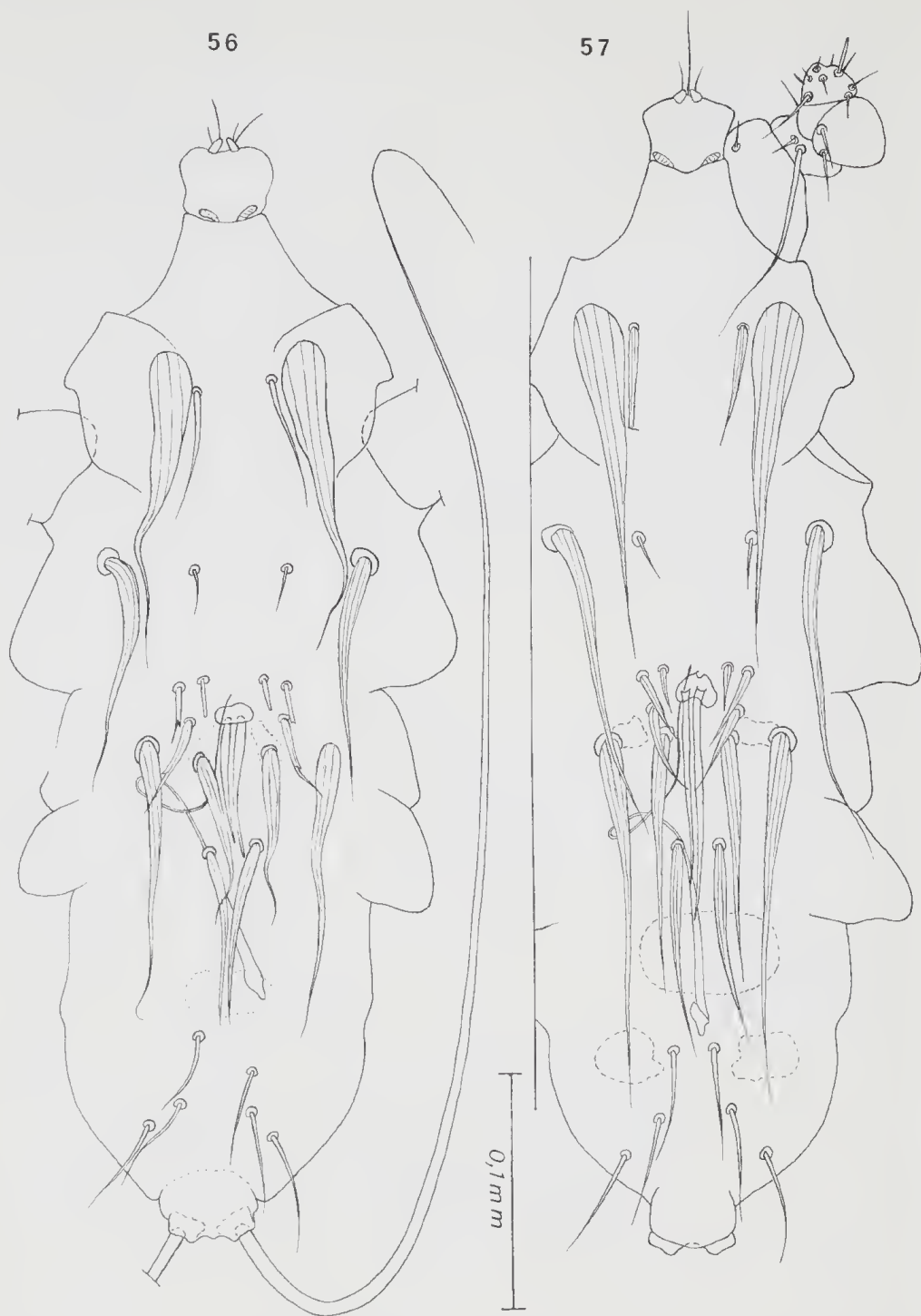
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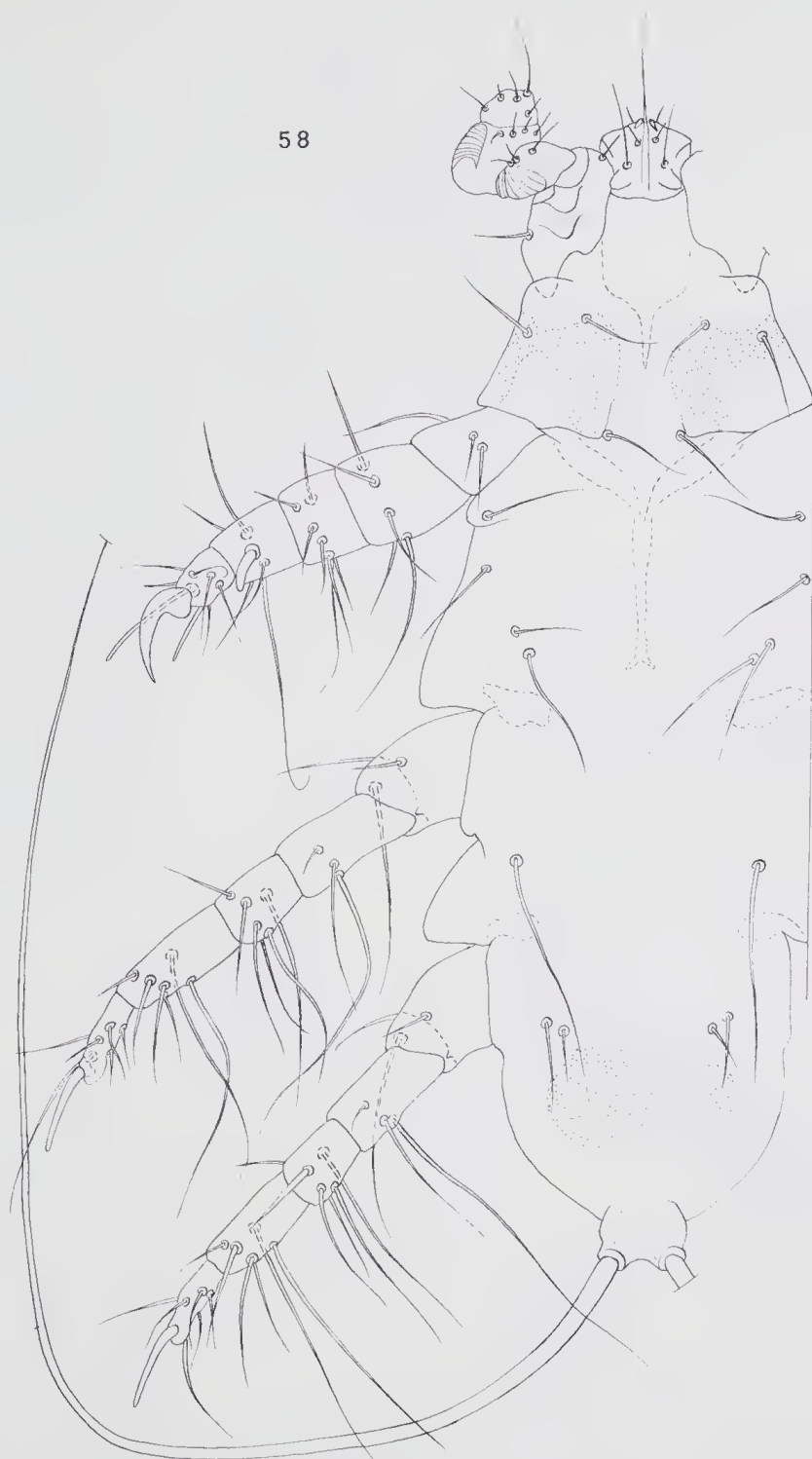


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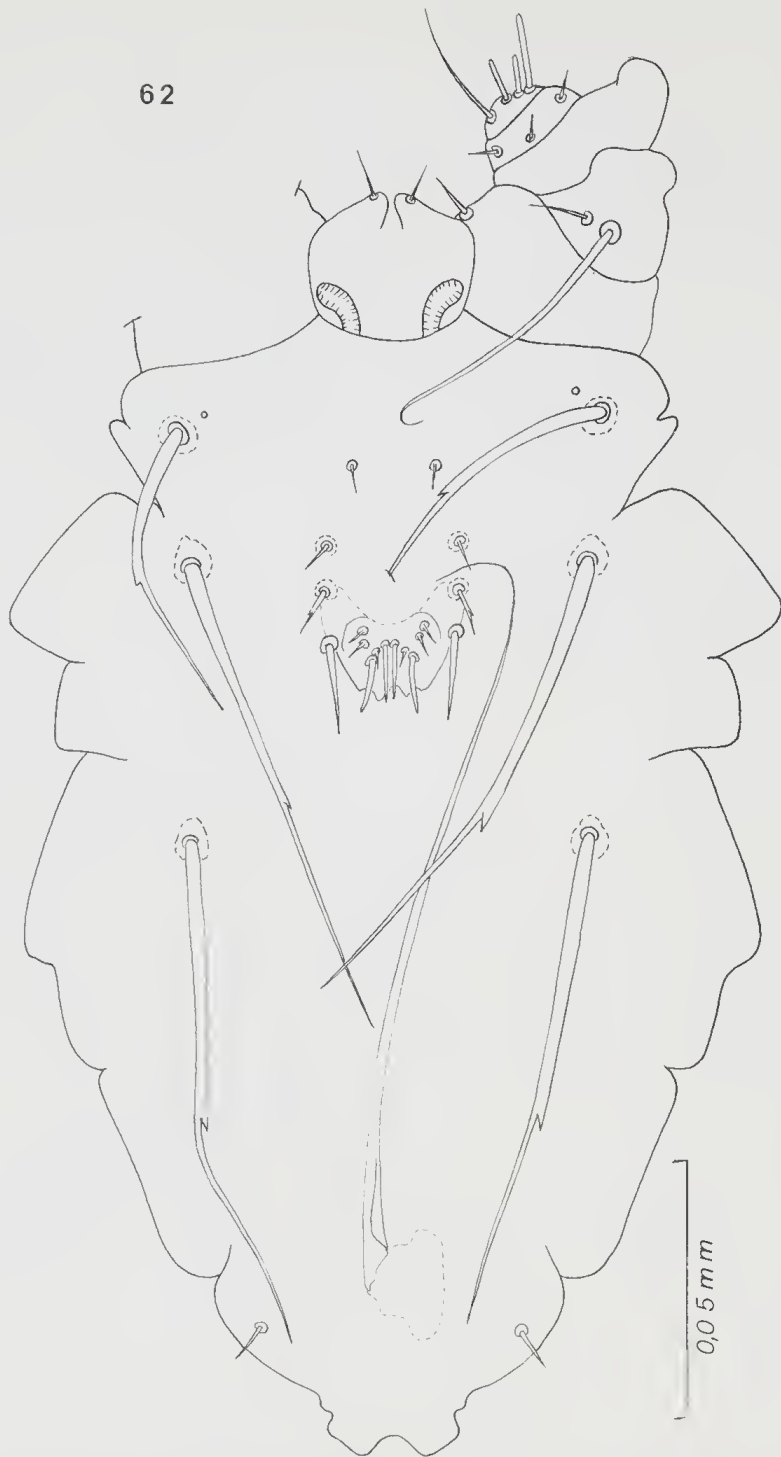
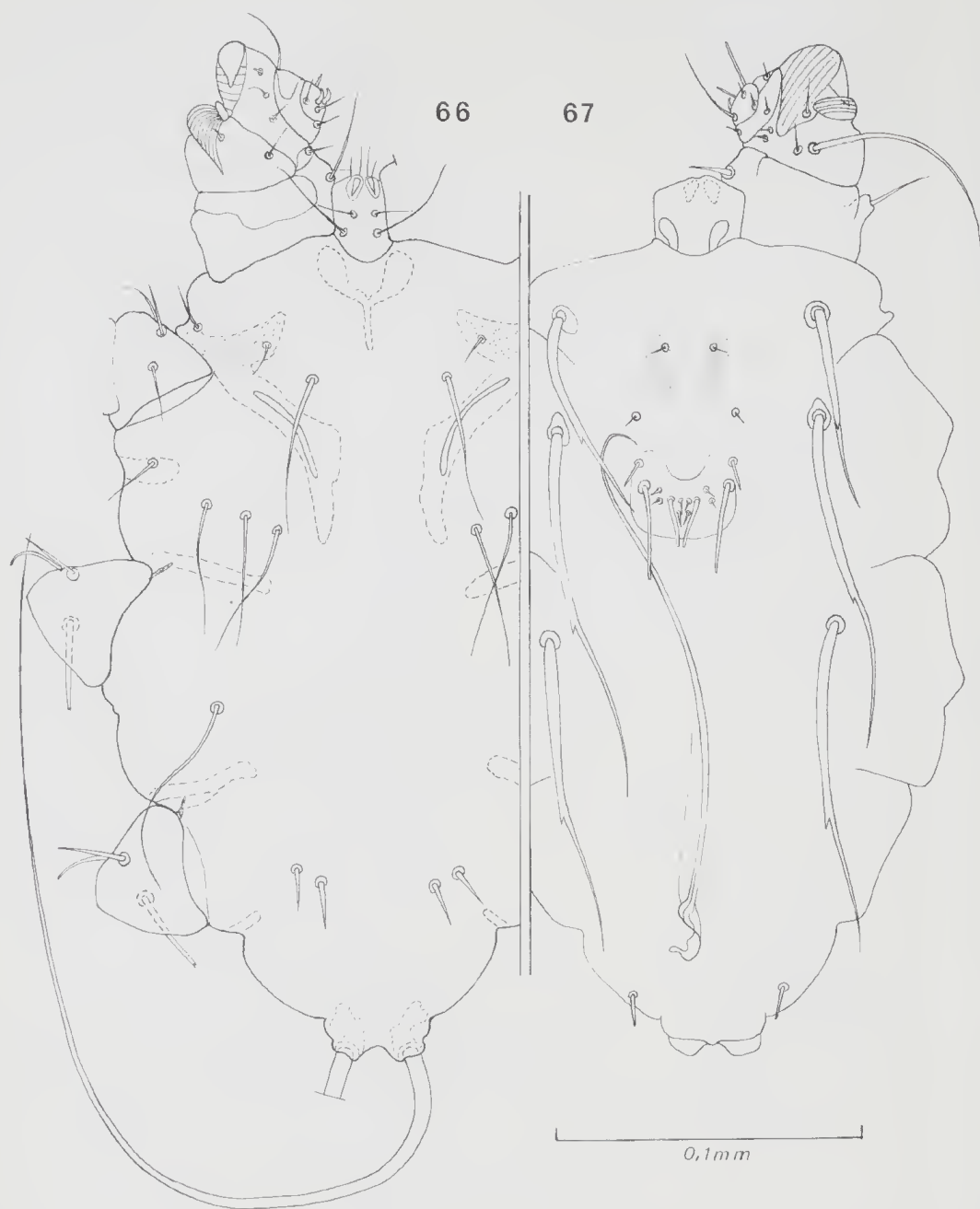


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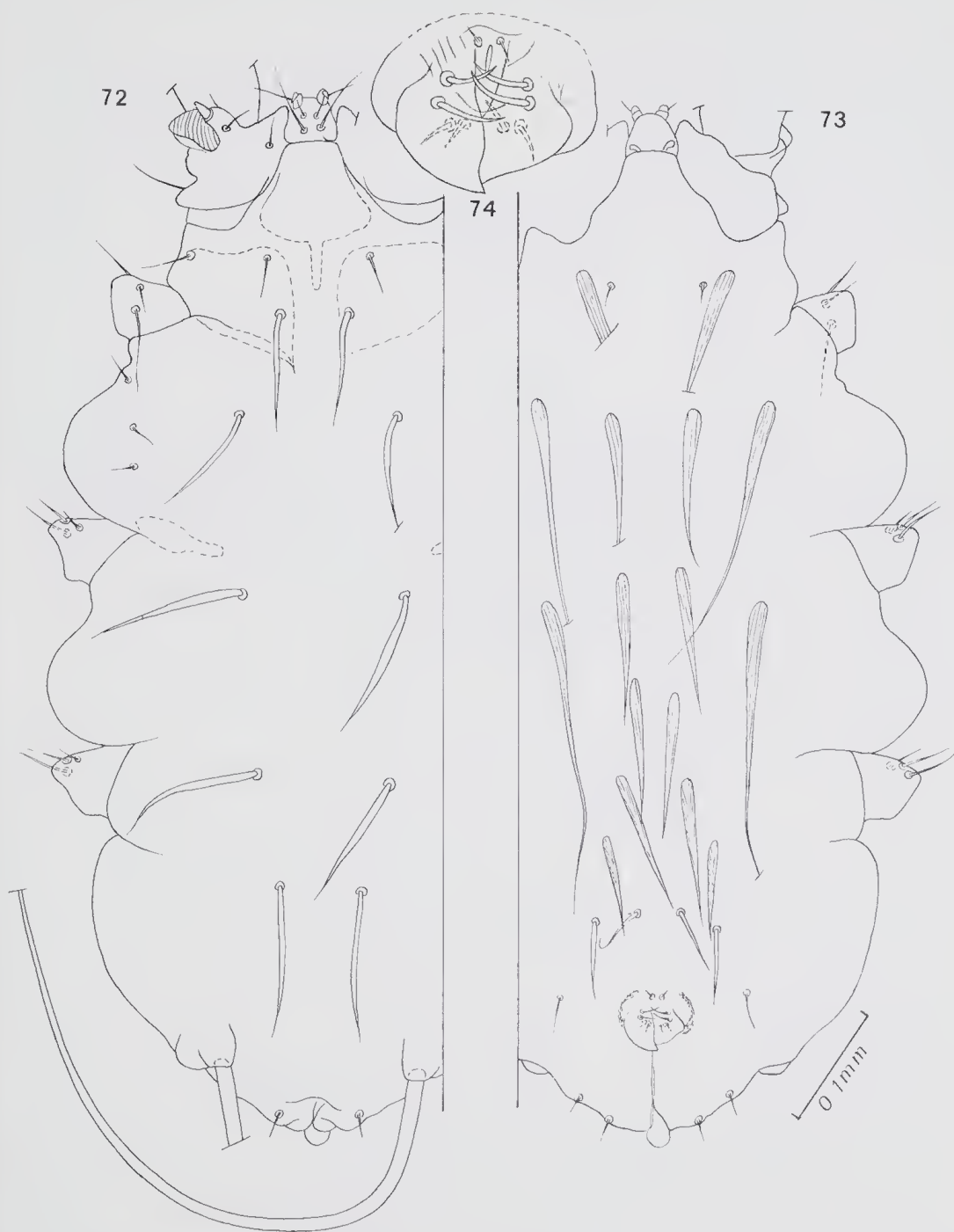


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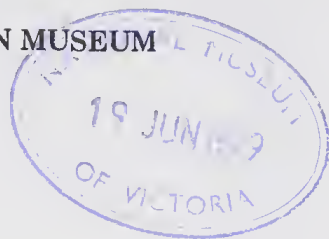
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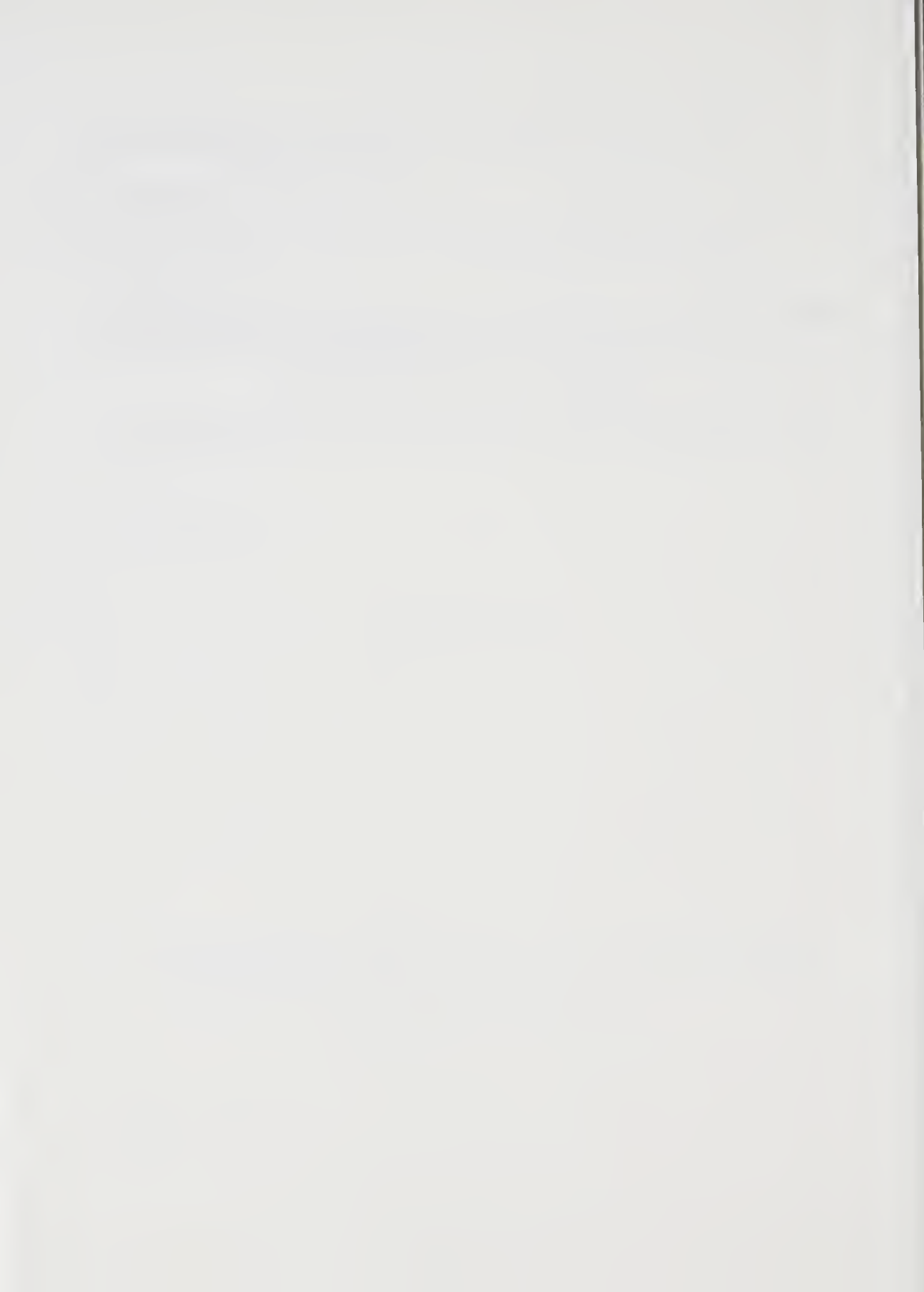


**THE SEPIIDAE (CEPHALOPODA, DECAPODA)  
IN THE COLLECTIONS  
OF THE WESTERN AUSTRALIAN MUSEUM**

*by*

**W. ADAM**

**VOLUME 7, PART 2, 1979**



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# THE SEPIIDAE (CEPHALOPODA, DECAPODA) IN THE COLLECTIONS OF THE WESTERN AUSTRALIAN MUSEUM

W. ADAM\*

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## ABSTRACT

In the present paper the following sixteen species of Sepiidae in the collections of the Western Australian Museum are described in detail from Western Australian localities: *Sepia apama* Gray, 1849 (♂, ♀, shell), *S. chirotrema* Berry, 1918 (♂, ♀, shell), *S. novaehollandiae* Hoyle, 1909 (♂, ♀, shell), *S. irvingi* Meyer, 1909 (♂, ♀, shell), *S. cultrata* Hoyle, 1885 (shell), *S. elliptica* Hoyle, 1885 (♂, ♀, shell), *S. smithi* Hoyle, 1885 (♂, shell), *S. papuensis* Hoyle, 1885 (♂, ♀, shell), *S. pharaonis* Ehrenberg, 1831 (♂, ♀, shell), *S. rex* (Iredale, 1926) (♂, ♀, shell), *S. rozella* (Iredale, 1926) (shell), *S. braggi* Verco, 1907 (♂, ♀, shell), *S. vercoi* sp. nov. (♂, shell), *S. cottoni* sp. nov. (♂, ♀, shell), *S. reesi* sp. nov. (shell), *Sepia* (*Metasepia*) *pfefferi* Hoyle, 1885 (♀, shell).

In a supplementary note, three species are described from non-Western Australian localities: *Sepia mestus* Gray, 1849 (shell), *S. plangon* Gray, 1849 (shell), *S. bandensis* Adam, 1939 (♂, ♀, shell).

## INTRODUCTION

In their review of the cephalopod family Sepiidae, Adam & Rees (1966) discussed all the known species of this family. Unfortunately material of most of the numerous described Australian species was lacking and these species could not be studied in detail.

Of the majority of the Australian species of *Sepia* only the shells have been described, although Iredale (1926, p. 188) stated that he had examined the animals of half of the species represented in the Australian fauna and

---

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that he proposed to describe them in his larger essay; the latter was never published.

The present study proves once again that in many cases it is absolutely necessary to study the animals and the shells for the identification of the species.

The geographical distribution given for each species is based on the collected animals and cuttlebones. As the latter may be transported by sea currents over great distances, their presence in a certain locality is no reliable indication that the animal really inhabits this region. As the majority of the references for the Australian fauna are based on the cuttlebones, the geographical distribution given in this paper has only a very limited significance.

#### ABBREVIATIONS

A.L.I.	length of dorsal arms (measured from the first proximal sucker to the distal arm tip)	M.L.d.	dorsal length of mantle
		M.L.v.	ventral length of mantle
		M.Th.	thickness of mantle
		M.W.	width of mantle
A.L.II	length of dorso-lateral arms	N.S.W.	New South Wales
		N.T.	Northern Territory
A.L.III	length of ventro-lateral arms	Qld	Queensland
		S.a.	diameter of arm suckers
A.L.IV	length of ventral arms	S.A.	South Australia
F.L.	length of fins	spec.	specimen
fms	fathoms	S.t.	diameter of tentacular suckers
F.W.	width of fins	Str.z.	length of striated zone
H.L.	length of head	T.cl.	length of tentacular club
H.W.	width of head	T.L.	total length of tentacle
juv.	juvenile	W.A.	Western Australia
L.	length	WAM	Western Australian Museum
Loc.	locality		
m	metres		

## DESCRIPTION OF SPECIES

### *SEPIA APAMA* GRAY, 1849

(Plate 9, Fig. 1)

*Sepia apama* Gray, J.E., 1849: 103

Tryon, G.W., 1879: 194

McCoy, F., 1888: 325-327, pls 188-190

Whitelegge, Th., 1889: 282

Brazier, J., 1892: 11

Chapman, F., 1912: 23, pl. I

Suter, H., 1913: 1058, pls 67, 68, 69, fig. 1a

Hedley, Ch., 1918: M33

Adam, W., 1939: 51

MacPherson, H.J. & Chapple, E.H., 1951: 156

Adam, W. & Rees, W.J., 1966: 34, pl. 12, figs 64-67; pl. 45, fig. 269

*Lophosepion apama* Rochebrune, A.T. de, 1884: 92

Adam, W., 1944: 225

?*Amplisepia verreauxi* (non Rochebrune, 1884) Iredale, T., 1926: 194, pl. XXIII, fig. 1-2; 1954: 70

Iredale, T. & McMichael, D.F., 1962: 98

*Amplisepia apama* Iredale, T., 1926: 194; 1954: 70

Verco, J.C. & Cotton, B.C., 1928: 127

Cotton, B.C., 1929: 90; 1931: 40, fig. 2

MacPherson, J.H. & Gabriel, J.C., 1962: 408, fig. 478

MacPherson, J.H., 1966: 239

*Sepia (Amplisepia) apama* Cotton, B.C. & Godfrey, F.K., 1940: 431, fig. 419, 420

?*Sepia palmata* Owen, R., 1881: 134, pls. XXIV-XXV

Brazier, J., 1892: 13

Adam, W., 1939: 52

?*Amplisepia palmata* Iredale, T., 1954: 71

?*Amplisepia parysatis* Iredale, T., 1954: 71, pl. IV, fig. 1-2

*Sepia* sp. b. Voss, G.L., 1962: 3

## Type localities

Port Adelaide (*S. apama*); Sydney (*A. verreauxi* Iredale, non Rochebrune)  
Norfolk Island (*S. palmata*); Shark Bay (*A. parysatis*).

## Distribution

Southern Australia to at least as far north as Ningaloo (Point Cloates) in  
Western Australia and Port Jackson in New South Wales; Norfolk Island;  
? New Zealand.

## MATERIAL

### Spirit specimens

- 1 Safety Bay, W.A.; October 1937; WAM 310-37: 1 ♂
- 2 Cape Peron, W.A. (32°16'S, 115°43'E); November 1954; WAM 400-54: 1 ♂ (M.L.d. approx. 158 mm)
- 3 Armstrong Pt, Rottnest I., W.A., deep rock pools open to sea at low tide; March 1958; WAM 423-65: 1 juv. spec. (Plate 9, Fig. 1)
- 4 Quindalup, Geographe Bay, W.A.; March 1972; WAM 861-75: 1 ♀
- 5 Ningaloo Station, S of North West Cape, W.A., limestone reef, 2 m; September 1968; WAM 862-75: 1 ♀

### Dry specimens

- 6 Bunbury, W.A.; October 1928; WAM 500-76: 5 mandibulae
- 7 Cottesloe Beach, Perth, W.A.; February 1928; WAM 13362/3: 2 spec.
- 8 Hopetoun, W.A.; March 1929; WAM 501-75: 2 spec.
- 9 S of Naval Base Groyne, Cockburn Sound, W.A.; November 1965; WAM 511-65: 7 spec.
- 10 Bunker Bay, Cape Naturaliste, W.A.; June 1974; (a) WAM 765-75: 1 spec. (deformed) + 1 juv. spec.; (b) WAM 767-75: 4 spec.
- 11 Cape Peron, W.A. (32°16'S, 115°43'E); April 1975; (a) WAM 795-75: 2 spec. (incomplete); (b) WAM 796-75: 2 spec. (incomplete).
- 12 Two Peoples Bay, W.A.; January 1972; WAM 820-75: 1 spec.
- 13 Between Eastern I. and Seal I., Wallabi Group, Houtman Abrolhos, W.A.; April 1974; WAM 821-75: 1 spec.
- 14 Sorrento Beach, Perth, W.A.; November 1965; WAM 831-75: 8 spec.
- 15 Cape Le Grand, W.A.; January 1973; WAM 834-75: 2 spec.
- 16 Natural Jetty, Rottnest I., W.A.; April 1975; WAM 851-75: 1 spec.
- 17 No data (a) WAM 481-65: 2 spec.; (b) WAM 482-65: 2 spec.; (c) WAM 484-65: 1 spec.; (d) WAM 486-65: 1 spec. (broken).

TABLE 1  
Measurements of *Sepia apama*

1a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
5	♀	152	85	54	36	37	39	99	13	33	39	36	39	92	23	1.3	2.3
4	♀	100	87	48	37	41	43	100	18	40	45	45	50	105	27	2.0	3.0
3	juv.	61	85	61	28	38	48	89	-	36	36	36	39	115	16	1.6	2.8

1b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Loc.	Sex	L. in mm	W.	Th.	Str.z.
17c	-	340	34.5	11.8	59	10a	-	93	44	10.2	56
9	-	230	38	10.8	61	14	-	90	45.5	8.9	56
17a	-	220	37	10.5	64	9	-	89	46	10.7	55
17b	-	210	39	11.2	57	9	-	86	46	10.5	58
17a	-	210	40	11.2	62	14	-	83	46	10.8	55
16	-	205	38	11.2	58	14	-	74	44.5	8.1	54
13	-	160	44	11.8	56	10b	-	74	44.5	9.4	54
17b	-	152	42	9.5	58	7	-	73.5	45	9.1	64
9	-	152	41	10.8	60	7	-	73	44	8.9	59
5	♀	150	39	8.6	59	14	-	72	43.5	9.0	60
15	-	150	41	12.6	50	9	-	70	45.5	10.4	62
14	-	145	42	11.0	56	14	-	70	43	8.6	58
9	-	120	41.5	10.0	57	10b	-	64	45.5	9.1	61
14	-	115	44.5	10.4	61	3	juv.	61	44	9.5	57
12	-	113	44	12.4	58	10b	-	60	48.5	10.0	60
15	-	110	45.5	11.8	54	8	-	53	47	8.3	53
9	-	104	47	9.6	60	10b	-	51	49	9.8	61
4	♀	100	42	10.0	57	8	-	50	46.5	10.0	53

## Description

The animals correspond with the description given by Adam & Rees (1966: 35) and show the three characteristic papillae behind each eye.

The shells illustrate the gradual transformation, especially of the posterior portion. In the smallest specimens (Plate 9, Fig. 1) the general shape is broadly oval, a little bit wider in the anterior half. The dorsal surface is very flat in the anterior part, with a faint indication of three ribs; anteriorly it is finely granulous along the growth lines; in the posterior part the granulation is stronger and forms a reticulate or labyrinth-like pattern. The spine is straight, short, without keels, separated at the ventral side from the outer cone by a shallow groove which is radially ribbed. The ventral surface is very flat with a faint linear median groove in the striated zone and a broader shallow depression in the last loculus. The first striae, in the posterior part, are widely spaced, the other ones closer together, weakly convex, nearly straight in the middle. The inner cone is well-developed, its lateral limbs broad, fused to the outer cone, their outer border flat and shiny, slightly raised as a flatly rounded rim around the posterior depression. In the posterior half, the limbs of the outer cone are about as large as those of the inner cone, continuous between the spine and the inner cone as a narrow ledge. In these smallest specimens (L. = 50-53 mm) there is hardly a trace of the callous formation inside the inner cone. The anterior portions of the limbs of the inner cone are situated between the outer cone and the striated zone, at the outer side of the very narrow smooth marginal areas of the striated zone. With the growth of the animal, the shape of the shell changes gradually, the posterior part becoming more and more acuminate: the spine disappears, the posterior rim of the inner cone becomes flatter and longer, the posterior depression disappears, filled by the V-shaped callous formation. Shells with a length of about 150-200 mm show the typical form of the shell which Iredale (1954: 71, pl. IV, fig. 1-2) described and figured as '*Amplisepia parysatis*', whereas the larger shells have the typical form of *Sepia apama*, with the posterior portion still more acuminate.

## Remarks

The larger specimens of *Sepia apama* are very characteristic and easily recognizable but the very young shells, in which the callous formation inside the inner cone is hardly visible, strongly resemble the young shells of *Sepia novaehollandiae*. At a same length, the shell of the latter is relatively narrower, the sculpture of the posterior part of its dorsal surface is coarser and forms radiating ridges on the two wings of the outer cone (in young specimens the median ridges are not yet developed), its mid-dorsal rib is



narrower and more developed. The ventral surface of the shell of *Sepia novaehollandiae* is thicker, with a deeper median sulcus; the first striae of the striated zone are closer together and the outline of the other striae is more convex, the inner cone is nearly the same, but the posterior portion of its lateral limbs is narrower and the anterior parts separate the striated zone from its smooth marginal areas, the spine is stronger but, as in *Sepia apama*, separated from the outer cone by a shallow groove.

### SEPIA CHIROTREMA BERRY, 1918

(Plate 1, Figs 1-6; Plate 2, Figs 1-4; Plate 3, Figs 1-4; Plate 4, Figs 1-2)

*Sepia chirotrema* Berry, S.S., 1918: 268, fig. 57-61, pl. LXXIV, fig. 3-9, pls LXXV-LXXVII

Adam, W. & Rees, W.J., 1966: 50-52

*Mesembrisepia chirotrema* Iredale, T., 1926: 190, 191; 1954: 70

Verco, J. & Cotton, B.C., 1928: 127

Cotton, B.C., 1929: 89; 1931: 40, fig. 4

*Sepia (Mesembrisepia) chirotrema* Cotton, B.C. & Godfrey, F.K., 1940: 422, fig. 410-415

*Solitosepia hendryae* Cotton, B.C., 1929: 87, pl. XV, fig. 1-2

*Sepia (Solitosepia) hendryae* Cotton, B.C. & Godfrey, F.K., 1940: 421, fig. 409

*Glyptosepia hendryae* Iredale, T., 1954: 74

#### Type localities

Investigator Strait area, South of Kangaroo Island, South Australia (*S. chirotrema*); Rottnest Island, Western Australia (*S. hendryae*).

#### Distribution

South Australia to Dirk Hartog I., Western Australia.

In addition to the material examined in this study the following locality records in the literature are noted: Great Australian Bight, 80-120 fms, Investigator Strait area, S of Kangaroo I., S.A., 129°28'E, Great Australian Bight, S of Eucla, W.A., 80-120 fms (Berry, 1918). Cottesloe, Rottnest I., W.A. (Cotton, 1929). Robe, S.A. (Cotton, 1931). Geraldton, Rottnest I., Cape Leeuwin, W.A. Joslin, S.A., Pelsart Island, Abrolhos Group, (Iredale, 1954) (*S. chirotrema*). Cottesloe (Cotton, 1929). Princess Royal Harbour,

King George Sound, Pelsart Island, Abrolhos, Dirk Hartog Island, Rottnest Island (Iredale, 1954) (*S. hendryae*).

## MATERIAL

### Spirit specimens

- 1 W of Rottnest I., W.A. ( $32^{\circ}03'S$ ,  $114^{\circ}20'E$ ), 114-136 m; February 1964; WAM 421-65: 1 ♀ (Plate 1, Figs 3-4).
- 2 NW of Bluff Pt., W.A. ( $27^{\circ}40'S$ ,  $113^{\circ}20'E$ ), 131 m; October 1963; WAM 25-76; 1 ♂, 2 ♀, 3 juv. spec. (Plate 2, Figs 1-4).
- 3 W of Lancelin, W.A. ( $31^{\circ}05'S$ ,  $114^{\circ}55'E$ ), 114-122 m; February 1964; WAM 26-76, 2 juv. spec.
- 4 W of Guilderton, W.A. ( $31^{\circ}30'$  to  $31^{\circ}34'S$ ,  $115^{\circ}06'E$ ); March 1972; WAM 858-75: 2 juv. spec. (M.L.d. 10 mm and 21 mm).
- 5 W of Mandurah, W.A. ( $32^{\circ}33'S$ ,  $115^{\circ}04'E$ ), 110 m; November 1970; WAM 860-75: 1 ♀ (Plate 1, Figs 1, 2, 5 and 6).

### Dry specimens

- 6 Cottesloe Beach, Perth, W.A.; September 1927; WAM 502-76: 6 spec. (Plate 3, Figs 3-4).
- 7 Cottesloe Beach, Perth, W.A.; July 1928; WAM 503-76: 3 spec. (Plate 3, Figs 1-2).
- 8 Cottesloe Beach, Perth, W.A.; (a) WAM 504-76: 1 spec. (b) WAM 476-65: 5 spec. (c) WAM 477-65: 2 spec. + 2 broken shells (identified by Iredale as '*Solitosepia glauerti*'). (d) WAM 479-65: 1 spec.
- 9 Hopetoun, W.A.; March 1929; WAM 505-76: 8 spec. (Plate 4, Fig. 1).
- 10 S of Naval Base Groyne, Cockburn Sound, W.A.; November 1965; (a) WAM 498-65: 1 spec. (b) WAM 503-65: 2 spec. (c) WAM 504-65: 1 spec.
- 11 Sorrento Beach, Perth, W.A.; November 1965; (a) WAM 499-65: 1 spec. (b) WAM 500-65: 2 spec. + 1 broken shell; (c) WAM 507-65: 1 spec. (Plate 4, Fig. 2); (d) WAM 816-75: 5 spec. (damaged).
- 12 Ocean Beach, Augusta, W.A.; March 1975; (a) WAM 799-75: 1 spec. (b) WAM 817-75: 2 spec.
- 13 Salmon Bay, Rottnest I., W.A.; 1969; WAM 818-75: 1 spec.
- 14 Myalup Beach, Harvey, W.A.; September 1965; WAM 819-75: 1 spec.
- 15 No data (a) WAM 470-65: 3 spec. + 1 fragment; (b) WAM 471-65: 3 spec. (c) WAM 473-65: 2 spec. + 2 spec. (broken); (d) WAM 487-76: 1 spec.

TABLE 2

Measurements of *Sepia chirotrema*.

## 2a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
2	♂	70	74	51	33	20	39	80	9	26	24	30	37	86	18.5	2.3	4.3
5	♀	112	91	47	38	17	45	88	11.7	27	27	32	41	117	22.5	2.7	6.3
1	♀	78	79	45	29	28	35	85	9	26	26	28	36	90	15.5	1.3	3.5
2	♀	73	79	47	27	26	34	84	7	27	27	30	36	62	15	1.4	3.7
2	♀	63	83	44	29	27	35	89	8	32	32	32	43	80	16	1.6	4.0
2	juv.	50	80	45	28	34	34	80	6	30	30	30	40	110	16	1.8	4.0

## 2b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
13	?♂	159	27	8.8	67	5.0
6	?♂	154	28.5	8.6	67	5.5
6	?♂	153	27	10.8	62	5.2
6	?♂	152	29.5	9.2	68	5.9
15b	?♂	152	29.5	8.8	72	5.1
15b	?♂	150	28	9.3	71	5.2
7	?♂	150	29.5	9.3	72	6.3
6	?♂	148	28.5	8.1	68	5.4
14	?♂	144	30	9.0	71	4.2
15b	?♂	144	27.5	9.6	68	4.9
12b	?♂	142	29	9.2	72	—
7	?♂	139	29.5	9.4	70	6.1
7	?♂	137	29	9.1	66	5.8
8a	?♂	135	29	8.9	67	5.5
6	?♂	133	30	9.4	64	5.6
6	?♂	132	28	8.3	68	4.5
12b	?♂	125	29.5	10.0	62	5.2
10c	?♂	124	32	9.7	68	4.8
5	♀	112	34	10.7	68	—
15d	?♀	111	32.5	9.3	66	5.0
11d	?♂	110	31	9.5	63	5.4
11d	?♂	110	33.5	10.4	63	5.4
15a	?♂	108.3	32.5	10.3	64	5.5
10b	?♂	104.8	35.5	9.4	69	4.6
15a	?♂	101	33	10.4	58	5.4
10b	?♂	91.5	34.5	10.7	63	5.1
15a	?♂	90	36	11.6	69	—
9	?♀	89	29	7.3	66	5.6
9	?♀	86.5	25	7.2	70	4.0

2b (continued): Shell (in % of shell-length)

Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine
9	?♀	85.5	29	6.9	72	4.8
11b	?♀	84	29	7.6	70	5.0
10a	?♀	83.3	27.5	6.2	74	4.2
12a	?♂	82	37	11.0	60	4.9
15c	?♀	79.4	28	8.0	71	4.4
1	♀	78	28	—	—	—
9	?♀	76.8	29	7.8	73	4.6
9	?♀	75	29	6.0	73	4.9
9	?♀	74	32	8.6	72	5.3
2	♀	73	31.5	9.3	66	—
9	?♀	72	32	8.2	71	5.1
15c	?♀	72	31	7.2	72	4.2
8b	?♀	71.6	29	8.4	70	3.2
2	♂	70	38.5	11.5	59	—
9	?♀	70	30	8.3	71	4.7
11b	?♀	70	31.5	8.6	71	5.9
2	♀	66	31	9.1	65	—
8b	?♀	65	32	8.5	69	—
8b	?♀	62.5	32	7.7	66	3.2
2	juv.	52	34.5	9.0	60	—
11c	?♂	49.5	43	11.7	59	5.0
8b	?♀	46.2	33	7.6	68	—
8b	?♀	46.2	35	8.6	63	5.8
8d	?♀	38	39	8.9	66	4.7
8c	?♂	38	46	11.0	59	3.9
8c	?♂	26.3	52.5	9.5	59	—
11a	?♂	24	50.5	9.6	58	—
4	juv.	20.2	46.5	9.9	57	4.9
2	juv.	18.5	51	—	59	—
2	juv.	17.5	54	—	—	—

### Description

The few animals (Plate 1, Fig. 1) in this collection are rather small in comparison with the types of *Sepia chirorema*, especially the only male specimen, which measures 70 mm in dorsal mantle-length, but their main characters do not differ essentially from the original description. The dorsal arms are rounded at their outer sides, without swimming-membranes, but they are compressed and slightly keeled near the distal ends. Swimming-membranes are present on all the other arms and widest on the ventral ones.

The arm-suckers are quadriserial, those of the inner rows slightly larger than those of the marginal rows. In the female, the suckers of the ventrolateral and ventral arms are slightly larger than those of the dorsal and dorso-lateral arms; in the male this difference is much more pronounced and the suckers of all the arms are larger than those of a female of the same size. In the original specimens, these differences were still more pronounced. The left ventral arm of the male shows a beginning of the hectocotylization described by Berry (1918: 269); the basal two-thirds bears ten or eleven transverse rows of normal suckers, which attain their largest size in the fifth or sixth row, whereas on the distal third the suckers are abruptly much smaller; on the right ventral arm, the basal portion is the same, but the suckers diminish gradually in size on the distal part. In this young male specimen the distal part of the hectocotylus is not laterally compressed and the protective membranes are not wider, thickened and elevated; however this may be due to a stronger contraction during preservation. The tentacles are long and slender, their absolute length depending on the state of contraction. The tentacular stem is rounded at its outer side, more or less flattened on the inner side. The club is rather short, but well-developed and very characteristic (Plate 1, Figs 2-4). The swimming-membrane is strong and reaches beyond the base of the club for a short distance. The protective membranes (Berry, 1918: 269, calls these the swimming-membranes) are united at the base of the club and attached to the stem by a unique short membrane. The dorsal protective membrane is rather thick and wide, separated from the swimming-membrane by a deep cleft and perforated by three large openings (*fenestrae*), each situated opposite one of the three big tentacular suckers. In the very young specimens these openings do not yet seem to exist, but it is very difficult to ascertain this without damaging the membrane. The greater part of the club is occupied by a median series of three very big suckers, the second one being largest, the first one nearly as large, but the third one smaller. These three suckers have long slender stalks, each attached at the bottom of a deep pit, the dorsal wall of which is formed by the dorsal protective membrane which shows the above-mentioned opening near the bottom of the pit. These pits are separated by transverse membranes, which bear at their dorsal side, near the edge of the protective membrane, a single small sucker and at their ventral side a pair of still smaller suckers. The distal part of the club bears 40-50 small suckers. On the base of the club there is generally in the middle a sucker of variable size, sometimes already situated in a distinct pit and which may be considered as a fourth main sucker, without attaining the size of the three main suckers; this basal main sucker is also separated from the following main



sucker by a transverse ridge or membrane, bearing one sucker at the dorsal side and a pair of suckers at the ventral side. At the proximal side of the median basal sucker there may be one to three minute suckers; this may vary on the two clubs of the same animal. All the large suckers, those of the arms and of the tentacular clubs have their chitinous rings smooth, but the small suckers are finely dentate.

There does not seem to be any doubt that the above described animals belong to a single species, *Sepia chirotrema*, the animal of which was only known by the original description.

As to the shell, in the original description the author (Berry, 1918: 271, fig. 58-59) gave a partially reconstructed drawing of the shell of a female specimen (M.L.d. = 168 mm); the description (p. 272) was probably based on the same specimen. Cotton (1931: fig. 4) and Cotton & Godfrey (1940: fig. 413) gave new figures of a shell of *Sepia chirotrema*, which differ a good deal from the original reconstruction of the shell of this species. Without having seen any material it would have been justified to wonder if they really represented the same species. The few animals and the many dry shells which I had the opportunity to study seem to justify the solution of this problem, although many more animals are needed to arrive at a definite conclusion. In fact there seem to exist important differences between the shells of the females and those of the males.

The following description of the shells is first of all based on the shells extracted from the male and female specimens from the same station (Loc. 2), which animals do not show any specific differences. The description is completed by the study of the remaining material. A first rather unexpected observation was that the shell of the young male is relatively much wider than those of female specimens of the same size. This difference seems to disappear in larger animals, but the present collection contained only a female specimen of medium size (L. = 112 mm) and no larger animals at all; consequently it is impossible to ascertain this point, except by study of the numerous dry shells, which according to other characters, especially the ornamentation of the dorsal surface, may be attributed with some doubt to males or females (see table of measurements, p. 121 and 122).

In the shell of the male, the anterior end is rather acuminate (Plate 1, Figs 1-2), the posterior end more broadly rounded. The dorsal surface shows a very distinct, well limited, median rib and two less-developed lateral ribs separated at each side from the former by a flat surface, about as wide as the ribs. The whole dorsal surface is granulous; in the anterior portion these granules are disposed more or less along the growthlines, but on the lateral



parts, and especially on the posterior portion, the granules become more and more coarse and form an irregular reticulate pattern. At the base of the lateral parts of the outer cone, the granules are more elongate and form at each side an irregular keel, separated from the middle part of the dorsal surface by a groove. The terminal spine is strong, rounded without any keels, straight and directed upwards. Its base is thickened, more or less expanded, and forms in the large shells (Plate 3, Figs 1-2) a thick collar, separated from the spine by a circular, radially striated groove, and separated from the dorsal surface of the shell by a deep cleft, but united with the dorsal surface by calcareous pillars or septa. The ventral surface is rather flat, with a shallow median sulcus along its whole length. The inner cone is well-developed, its lateral limbs reflected and fused with the outer cone, their lateral and ventral margins more or less rose-coloured, shiny and thickened in the posterior portion, which surrounds a distinct posterior depression. Along about half the length of the striated area, the posterior parts of the limbs of the inner cone are rather wide, diminishing gradually towards the anterior end. Along the anterior half of the striated zone, the limbs of the inner cone are very narrow, slightly raised ridges. At each side, the striated area is generally separated from the limbs of the inner cone by a narrow non-striated zone. On the other hand, the striated area is at each side separated from the outer cone by a rather wide smooth zone; in the small male shell, the latter shows a faint transverse striation. The striae of the striated area are convex in its posterior part, weakly angular, reversed V-shaped near the last loculus. The outer cone is rather narrow along the greater part of its length; it is more expanded and broadly rounded in its posterior portion, forming two wings in the larger specimens; it is continuous between the posterior part of the inner cone and the spine. The shell of the female is much narrower than that of the male in the small specimens (Plate 2, Figs 3-4; Plate 4, Fig. 1); it is flatter and presents a more slender general form, more acuminate at its anterior end, less expanded at the posterior end. The ribs of the dorsal side are less pronounced and the areas between the median and the lateral ribs less flattened (Plate 1, Figs 5-6; Plate 3, Figs 3-4). The whole dorsal surface is less rugose, but the keels at the bases of the lateral parts of the outer cone exist. The base of the spine is not thickened and expanded (Plate 3, Figs 3-4) as in the shell of the male. On the other hand, the spine shows sometimes a very weak ventral keel or a dorsal keel, or both. The ventral surface, although generally flatter, shows a more distinct median sulcus over its whole length. The limbs of the inner and of the outer cone are narrower. In both sexes the well preserved shells are on their dorsal sides more or less salmon-coloured, especially those of the female. The sexual differences

between these shells are sufficiently pronounced to distinguish them even without having seen the animals. In fact, the shell figured by Cotton & Godfrey (1940: fig. 413) represents a typical male shell. But the shells we extracted from the small female animals do not differ at all from the shell which Cotton (1929: 87, pls. XV, fig. 1-2) described as '*Solitosepia hendryae*'. Before having examined the animals, I had separated the abovementioned dry shells in two species: *Sepia chirotrema* and *Sepia hendryae* (the animal of the latter had never been described). When I studied the animals, it turned out that the only male specimen possessed a '*chirotrema*'-like shell, whereas the young females had a '*hendryae*'-like shell. The reconstructed female shell, figured by Berry (1918: fig. 58-59) also strongly resembles the latter species.

## Discussion

The above-described animals have such a characteristic tentacular club, which is the same in the male and in the female specimens, that we can hardly believe that these animals, especially those captured together (Loc. 2) could belong to different species. Of course we cannot absolutely exclude this possibility, because the John Murray Expedition captured in the same locality (Stat. 75, Gulf of Oman) male and female specimens of *Sepia prashadi* Winckworth, 1936 and of *Sepia omani* Adam & Rees, 1966. The tentacular clubs of these two species show only minor differences, but the shells are completely different (see: Adam & Rees, 1966: 26 & 92). In the present case the tentacular clubs are absolutely the same and the shells show lesser differences. If my interpretation is correct, the shells of the males and females have not only been described as belonging to different species, but have been placed in different genera: the male in *Mesembrisepia* and the female in *Solitosepia* or *Glyptosepia*.

Iredale (1926: 188), who unfortunately never described the animals of his numerous different species, stated: 'that if an animal be met with it may be recognised and the bone will absolutely determine the species'. And in 1954 (p. 63), the same author, speaking about the 'bones', stated: 'the conclusions here recorded from their study, will be found to be stable when the animals are treated in as much detail'. After our experience with *Sepia chirotrema* and *Sepia hendryae*, it would be very interesting to study the animals of more Australian species.

Up to the present, *Sepia chirotrema* seemed to have been the only species in which the tentacular club possesses in the dorsal protective membrane openings (*fenestrae*) at the level of the big suckers. In this respect, I can add three other species which possess these openings: *Sepia prashadi*

Winckworth, 1936, *Sepia omani* Adam & Rees, 1966, and *Sepia rex* (Iredale, 1926) (see p. 178). In the original description of *Sepia omani*, we did not mention them, but in re-examining some of the paratypes (all the types were rather small), I discovered at the spots where *Sepia chirotrema* shows these openings, a very thin membrane, which was sometimes damaged. But in much larger specimens from Hong Kong, which Dr G.L. Voss kindly put at my disposal there are in each club three distinct openings at the levels of the three biggest suckers. In *Sepia prashadi* I found only two openings at the levels of the biggest suckers. The tentacular clubs of *Sepia rex* have been described on page 178. It is possible that in other species with very big suckers, these openings may exist and have been overlooked. Sometimes it is very difficult, owing to the contraction during fixation, to examine the dorsal protective membrane without damaging it. In *Sepia (Metasepia) pfefferi* I did not see any openings (see page 204).

According to Iredale (1926: 191) *Sepia chirotrema* appears to be the benthic form of *Sepia novaehollandiae*. Cotton (1929: 89) was of the same opinion. It is clear from the description (p. 135) of *Sepia novaehollandiae*, the animal of which was unknown up to the present, that these two species are quite distinct. The shells certainly show a certain resemblance, but differ in many details, especially as regards the sculpture of the posterior part of the dorsal surface. These differences are less pronounced in the females than in the males.

## *SEPIA NOVAEHOLLANDIAE* HOYLE, 1909

(Plate 7, Figs 1-5; Plate 8, Figs 1-2)

*Sepia australis* Férussac, A. de, 1835: pl. VII, fig. 4

Orbigny, A. d', 1845: 294

Férussac, A. de & Orbigny, A. d', 1848: 285, pl. VII, fig. 4

Hoyle, W.E., 1886: 22, 220 (*non* Quoy & Gaimard, 1832)

*Sepia novaehollandiae* Hoyle, W.E., 1909: 266

MacPherson, J.H. & Chapple, E.H., 1951: 156

Adam, W. & Rees, W.J., 1966: 48, pl. 15, fig. 84-90

*Mesembrisepia novaehollandiae* Iredale, T., 1926: 191; 1954: 68

Verco, J.C. & Cotton, B.C., 1928: 127

Cotton, B.C., 1929: 88; 1931: 40, fig. 3

MacPherson, J.H. & Gabriel, C.J., 1962: 409

*Sepia (Mesembrisepia) novaehollandiae* Cotton, B.C. & Godfrey, F.K., 1940: 428, fig. 418 (*non* fig. 416, 417)

## Type locality

Kangaroo Island, S. Australia.

## Geographical distribution

Southern Australia from Victoria and Tasmania to Point Cloates in Western Australia.

## MATERIAL

### Spirit specimens

- 1 Off Naval Base, Cockburn Sound, W.A., 6 m on *Posidonia* banks; August 1958; (a) WAM 415-65: 2 ♂ (Plate 7, Figs 1-2); (b) WAM 416-65: 1 ♂.
- 2 Cockburn Sound, W.A.; July 1951; WAM 417-65; 1 spec. (M.L.d. 74 mm).
- 3 ? Shark Bay, W.A.; 1962; WAM 418-65; 2 spec. (M.L.d. 72 mm and 79 mm).
- 4 SW of Pt Cloates, W.A. (23°39'S, 113°11'E), 134 m; October 1963; WAM 422-65: 2 juv. spec.
- 5 SW of Pt Cloates, W.A. (24°04'S, 112°52'E), 135 m; October 1963; WAM 438-65: 1 juv. spec. (M.L.d. 39 mm).
- 6 W of Rottnest I., W.A. (32°00'S, 115°08'E), 137 m; August 1963; WAM 439-65: 2 juv. spec. (M.L.d. 31 mm and 38.5 mm).
- 7 North Cottesloe Beach, Perth, W.A.; July 1916; WAM 9357: 1 ♂ (M.L.d. 120 mm).
- 8 NE of Pelsart Group, Houtman Abrolhos, W.A.; August 1970; WAM 863-75: 1 ♀.
- 9 Cockburn Sound, W.A.; July 1972; WAM 864-75: 2 ♂ (M.L.d. 90 mm and 125 mm), 1 ♀ (M.L.d. 103 mm).
- 10 Off Rockingham and Kwinana, Cockburn Sound, W.A.; February 1970; (a) WAM 866-75: 1 ♂, 3 ♀ (Plate 7, Fig. 3); (b) WAM 867-75: 2 ♂, 3 ♀, 2 juv. spec. (one in bad condition: M.L.d. 62 mm); (c) WAM 868-75: 1 ♂, 3 ♀.
- 11 Shark Bay, W.A.; early 1966; WAM 869-75: 1 ♀ (M.L.d. 125 mm).
- 12 60 km NW of Cape Cuvier, W.A., 155-172 m; July 1972; WAM 876-75: 1 ♀, 1 ♂ (misformed) (Plate 8, Figs 1-2).
- 13 No data WAM 426-65: 1 juv. spec.

### Dry specimens

- 14 Rottnest I.(?), W.A.; WAM 475-65: 12 spec. + 2 broken shells.
- 15 S of Naval Base Groyne, Cockburn Sound, W.A.; November 1965; (a) WAM 28-76: 47 spec.; (b) WAM 506-65: 14 spec. + 3 broken shells.



- 16 Sorrento Beach, Perth, W.A.; November 1965; (a) WAM 29-76: 5 spec. (Plate 7, Figs 4-5); (b) WAM 510-65: 10 spec. + 1 broken shell.
- 17 Bunker Bay, Cape Naturaliste, W.A.; June 1974; (a) WAM 764-75; 1 spec.; (b) WAM 766-75: 3 spec.
- 18 West End, Rottnest I., W.A.; June 1974; WAM 783-75: 1 spec.
- 19 Deadwater, near Hardy Inlet, Augusta, W.A.; March 1975; WAM 784-75: 4 fragments.
- 20 S of Woodman Pt, Cockburn Sound, W.A.; July 1965; WAM 788-75: 1 spec.
- 21 Two People Bay, W.A.; January 1972; (a) WAM 789-75: 1 spec. (b) WAM 792-75: 1 spec.
- 22 Between Eastern I. and Seal I., Morning Reef, Wallabi Group, Houtman Abrolhos, W.A.; April 1974; WAM 790-75: 1 spec. incomplete.
- 23 Ocean Beach, Augusta, W.A.; March 1975; (a) WAM 791-75: 6 spec.; (b) WAM 797-75: 3 spec. + 1 spec. incomplete; (c) WAM 30-76; 1 spec.; (d) WAM 800-75: 11 spec. + 4 damaged spec.
- 24 Coast between Middle Mt Barren and Thumb Peak, Fitzgerald River Reserve, W.A.; January 1971; WAM 793-75; 1 spec.
- 25 Cape Peron, W.A. (32°16'S, 115°43'E); April 1975; WAM 794-75: 1 incomplete spec.
- 26 Cheyne Beach (Hassell Beach), W of Cape Riche, W.A.: December 1968; WAM 798-75; 2 spec. + 2 fragments.
- 27 Cape Le Grand, W.A.; January 1973; WAM 807-75: 6 spec.
- 28 Back Beach, Geraldton, W.A.; September 1974; WAM 808-75; 5 spec.
- 29 Windy Harbour, E of C. d'Entrecasteaux, W.A.; March 1965; WAM 811-75: 10 spec.
- 30 Myalup Beach, Harvey, W.A.; September 1965; WAM 814-75: 1 spec.
- 31 Longreach Bay, Rottnest I., W.A.; April 1975; WAM 852-75: 2 spec.
- 32 Salmon Bay, Rottnest I., W.A.; September 1931; WAM 819-31: 1 spec.
- 33 Cottesloe(?), W.A.; (a) WAM 1286-76: 14 spec.; (b) WAM 1287-76: 7 spec.; (c) WAM 1288-76: 6 spec.
- 34 Cottesloe Beach, Perth, W.A.; July 1928; WAM 13660/80: 21 spec.
- 35 Hopetoun, W.A.; March 1929; WAM 1289-76: 1 fragment.
- 36 No data (a) WAM 27-76: 19 spec.; (b) WAM 480-65: 1 spec.; (c) WAM 487-65: 19 spec.

TABLE 3

Measurements of *Sepia novaeollandiae*

3a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I.	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
1b	♂	136	72	46	—	37	40	99	18.5	44	48	57	59	88	20	1.5	2.1
1a	♂	132	84	45	—	27	36	98	13.5	42	40	43	51	72	19	1.4	1.8
1a	♂	113	75	47	—	38	37	100	19.5	42	44	46	53	88	20	1.8	2.0
10c	♂	82	89	45	32	35	35	92	12	37	43	37	49	135	18	1.5	1.5
10b	♂	79	86	47	30	32	42	93	11.5	38	44	44	51	140	19	1.5	1.6
10a	♂	78	86	49	31	32	38	90	9	45	38	45	49	166	18	1.5	1.7
10b	♂	75	87	47	33	36	37	91	5.3	40	40	40	40	120	17	1.6	1.7
8	♀	100	91	38	36	41	36	102	13	40	45	45	45	—	16	1.3	1.3
10a	♀	89	84	48	34	34	40	94	11	39	34	39	39	100	18	1.3	1.6
10b	♀	83	87	47	37	34	37	93	11	42	42	48	48	132	18	1.6	1.6
10b	♀	76	87	50	37	33	43	89	10.5	33	33	33	39	92	16	1.4	1.6
10c	♀	76	87	43	35	30	39	89	8	39	33	33	39	86	18	1.6	1.7
10a	♀	73	86	44	34	29	40	95	8	34	34	34	41	—	—	1.4	—
10c	♀	71	87	48	34	32	38	92	14	32	35	35	39	92	20	1.5	1.8
10a	♀	66	88	45	30	30	41	87	12	33	33	33	38	91	15	1.5	1.7
10c	♀	61	89	51	34	36	43	92	10	36	33	36	44	107	20	1.5	1.5
13	juv.	64	82	45	—	31	39	94	10	36	36	38	39	102	17	—	—
10b	juv.	58	90	48	38	36	38	90	12	35	35	35	43	104	16	1.4	1.6



3b: Shell (in % of shell-length)

Loc	Sex	L.in mm	W.	Th.	Str.z.	Spine	Loc	Sex	L. in mm	W.	Th.	Str.z	Spine
16b	—	170	28	11.8	70	—	34	—	130	30.5	10.0	62	5.0
34	—	165	25.5	8.1	—	3.0	34	—	130	29.5	12.3	—	3.9
27	—	158	29	11.4	61	4.4	23b	—	130	29	9.2	69	5.4
12	♀	153	29	9.1	73	3.3	28	—	130	27	10.0	61	3.5
28	—	150	28	10.6	64	3.3	12	♂	128	27.5	9.4	73	3.1
26	—	146	27.5	8.9	73	4.1	36c	—	127.8	29.5	9.7	67	4.7
33a	—	145	30	9.6	62	4.5	33b	—	127	27.5	—	—	3.5
31	—	143	28.5	9.1	73	4.9	29	—	127	29	8.7	65	3.2
31	—	142	27.5	9.9	75	4.2	15b	—	126	31	10.9	—	4.6
27	—	140	28	8.9	67	—	15b	—	125.5	31	9.6	—	4.0
33a	—	140	26.5	9.3	68	3.9	34	—	125	33.5	10.8	61	4.0
28	—	139	25	9.7	65	—	21a	—	125	33	9.6	68	4.8
33a	—	138	29	9.4	72	4.7	27	—	125	31	9.6	70	3.6
36c	—	137	29.5	8.7	72	4.4	33a	—	124	31.5	10.0	60	4.0
16b	—	136.5	28	11.5	59	4.8	16b	—	124	31	8.4	—	3.5
1b	♂	136	33	11.8	70	—	16b	—	123.5	29	9.7	67	4.1
17a	—	136	26.5	8.4	70	3.7	15a	—	123.4	32.5	10.8	64	4.6
16b	—	135	31	10.4	72	3.7	33a	—	123	32	10.2	55	4.5
29	—	135	30.5	9.1	67	3.0	34	—	123	30	9.8	67	3.3
34	—	134	30	10.4	69	4.9	34	—	123	31.5	10.6	55	4.9
15b	—	133	31.5	9.4	—	4.5	15a	—	122	32	9.0	—	—
15a	—	133	31.5	9.4	66	4.5	34	—	121	30.5	9.5	63	3.3
36a	—	132.5	27	9.4	—	4.0	34	—	121	30	8.7	70	4.1
27	—	132	29.5	9.1	66	4.6	36c	—	121	30	9.5	69	4.5
34	—	131	29	9.4	69	4.6	34	—	120	33	8.4	71	3.8
15a	—	131	29	9.3	66	—	36a	—	120	32	10.0	63	5.0

3b: Shell (in % of shell-length) cont.

Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine
36a	—	119	32	10.9	69	4.6	15a	—	111	32	10.4	—	4.5
15a	—	119	30.5	9.2	64	4.6	16b	—	110.5	31	9.5	74	5.0
15a	—	119	32	9.2	71	4.2	34	—	110	31	9.6	68	4.1
23d	—	119	31.5	8.8	67	4.2	34	—	110	32	9.5	—	3.6
34	—	118	30.5	9.3	—	3.4	15a	—	110	30	10.4	62	4.8
34	—	118	34	10.2	66	4.2	36a	—	110	33.5	10.6	66	5.0
33a	—	117	32	—	—	3.9	23d	—	110	33.5	10.0	73	5.4
36a	—	116.5	32.5	8.6	—	—	23d	—	110	30	8.6	66	3.6
33a	—	116	33	11.2	65	4.3	23d	—	110	32.5	8.6	—	3.6
23b	—	116	33	9.1	72	5.2	15d	—	110	31	10.0	66	4.1
36c	—	115.5	30	9.7	59	3.9	15d	—	110	32	9.6	61	3.6
34	—	115	29.5	11.3	62	4.4	21b	—	110	32	9.1	70	4.6
15a	—	115	29	9.6	64	4.8	29	—	110	30	9.2	71	2.3
36a	—	114.5	31.5	9.1	66	4.4	36a	—	109.5	30	9.8	67	5.0
15a	—	114.5	32	10.2	—	4.4	36c	—	108.3	32	11.4	—	4.6
36a	—	114	31.5	—	—	5.3	16b	—	108	29.5	9.4	—	4.2
36a	—	114	30.5	9.2	69	4.4	15a	—	108	32.5	9.2	71	4.1
15b	—	114	31.5	11.0	60	4.8	36c	—	107.5	29	10.4	60	4.1
29	—	114	31.5	9.0	70	4.4	33a	—	107	31	9.3	69	4.2
36a	—	113	31	—	—	4.9	15b	—	107	32.5	9.4	71	4.7
36c	—	112.2	29	9.2	67	4.5	15a	—	107	31	8.9	73	4.7
36a	—	112	31.5	—	—	4.5	15a	—	106.8	32	11.0	61	5.0
36c	—	112	27.5	8.7	—	2.9	15a	—	106.5	31.5	10.3	61	3.9
34	—	112	32	10.3	63	4.5	36c	—	106.2	29	10.1	—	4.1
15b	—	112	30.5	10.3	63	4.5	33a	—	106	35	9.9	59	3.8
15a	—	112	33	9.8	68	4.5	29	—	106	31.5	9.4	73	3.8
36a	—	111.4	34	10.3	62	4.0	29	—	106	34	10.4	60	2.4

3b: Shell (in % of shell-length) cont.

Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine
33a	—	105	31	10.0	54	4.3	36a	—	97	28	—	—	3.6
34	—	105	31.5	10.0	65	4.8	23a	—	97	31	8.2	65	4.1
23a	—	105	28.5	9.5	62	3.8	15a	—	97	32	9.3	62	4.1
36c	—	104.8	29.5	9.0	66	4.8	36a	—	96.5	28.5	—	—	4.1
15a	—	104	34	10.1	60	4.5	36c	—	96	36	11.2	72	4.7
15b	—	104	31.5	11.8	57	4.3	15a	—	96	34.5	10.4	66	4.4
36c	—	103.5	34	10.0	67	4.1	23b	—	96	32.5	8.3	76	4.2
36c	—	103	30	10.0	—	3.9	23d	—	96	30	9.4	68	3.6
15a	—	103	35	9.7	68	5.8	15a	—	96	33.5	9.4	60	4.7
15a	—	103	34	9.7	67	—	15a	—	96	34.5	9.4	71	4.2
9	♀	103	34	10.2	66	—	33a	—	95	32	10.3	58	4.7
15a	—	102	31.5	9.8	59	4.4	15a	—	95	34	10.0	68	4.2
33a	—	100	34	11.0	58	4.0	15a	—	95	36	10.7	68	—
33a	—	100	34	9.5	—	4.5	23a	—	95	32.5	10.5	59	4.2
33b	—	100	33.5	9.5	69	—	34	—	94	34	10.1	61	4.2
16b	—	100	31	9.5	63	4.5	15a	—	92	32.5	10.4	60	4.3
8	♀	100	31	10.0	71	3.0	36a	—	91.3	31	9.9	61	3.8
27	—	100	32	8.5	68	4.5	16b	—	91	28	9.0	67	2.8
23d	—	100	31	8.5	70	5.0	28	—	90	31	10.0	56	3.3
36a	—	99	29.5	10.2	62	4.0	33b	—	89	31.5	9.0	—	3.9
34	—	99	33	9.7	—	3.5	33b	—	88	33	9.1	—	4.0
29	—	99	33.5	9.1	68	3.5	36a	—	87.5	34	—	—	5.7
29	—	98	34	8.1	71	2.0	10a	♀	87	34.5	10.4	54	4.0
33c	—	97.4	32.5	9.2	65	5.1	15a	—	87	33.5	9.8	69	4.6
33b	—	97	31	10.3	—	4.6	15a	—	86.8	33.5	10.0	66	5.0
33c	—	97	33.5	9.1	68	4.6	23d	—	86	30	9.3	61	3.5
15b	—	97	31.5	10.3	64	5.1	15b	—	85.5	33	8.9	66	3.9

3b: Shell (in % of shell-length) cont.

Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc	Sex	L. in mm	W.	Th.	Str.z.	Spine
23a	—	85	34	10.6	59	—	15a	—	69.8	37	—	—	4.6
10b	♀	83	35	10.8	51	3.6	15b	—	68.3	36	9.1	—	4.4
33a	—	83	33.5	10.2	57	5.4	15a	—	68	36	—	—	4.4
36b	—	82	29.5	9.2	—	4.1	24	—	68	34	9.6	68	3.7
23a	—	82	35.5	8.5	63	3.7	36c	—	66	34	9.5	54	5.2
36c	—	81.4	32	10.5	—	4.9	15a	—	66	34	9.1	61	4.5
33b	—	81	36	—	—	4.9	33c	—	65	34	10.8	55	4.3
15b	—	81	34.5	9.3	74	4.3	16a	—	65	35.5	11.1	57	5.4
36a	—	80.5	33.5	10.8	56	5.0	13	juv.	64	34.5	11.4	55	—
10c	♂	80	34.5	10.6	50	—	15b	—	64	34	—	—	4.7
10b	♀	80	35	11.2	58	3.7	14	—	62.5	34.5	—	—	4.8
23d	—	80	33	9.4	71	—	36c	—	62	35.5	11.3	58	4.0
15b	—	79.7	34.5	10.6	63	4.8	29	—	59	34	11.4	58	2.5
23d	—	78	31.5	9.2	69	—	16a	—	56.7	33.5	10.4	60	4.2
34	—	77	31	9.1	64	3.9	14	—	56.5	34.5	9.2	55	5.0
33c	—	76	30.5	10.6	53	5.3	14	—	55.8	36	10.8	61	4.8
33c	—	75.8	30	—	—	6.1	14	—	55.7	33.5	—	—	3.6
36c	—	75	31.5	—	—	4.9	16a	—	55.3	37.5	10.8	66	5.4
23d	—	75	32	8.0	70	4.0	14	—	54.5	35.5	10.7	61	4.6
17b	—	75	37.5	12.6	59	4.7	14	—	53	36.5	11.0	60	5.7
23a	—	74	34	10.1	58	4.1	36c	—	52.6	34.5	10.4	50	4.8
20	—	74	35	9.5	63	3.4	26	—	52	33.5	10.6	69	4.8
10b	♂	73	35.5	10.3	52	4.1	17b	—	51	37	11.8	61	4.9
10a	♀	73	34	11.7	47	4.1	14	—	51	34.5	—	—	4.3
33c	—	73	32	—	—	5.5	16b	—	50	36.5	11.0	62	4.6
27	—	72	34.5	9.7	69	5.5	16b	—	49.5	34	10.1	61	4.7
33b	—	71.5	33.5	8.4	—	4.2	15a	—	49.2	36.5	12.6	59	4.5

3b: Shell (in % of shell-length) cont.

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
17b	—	49	34.5	10.6	57	4.1
16a	—	48	37.5	9.6	62	4.2
14	—	48	35.5	—	—	4.6
14	—	47	36	10.6	62	4.3
15b	—	43	37	10.5	60	5.8
14	—	40	36	10.2	59	5.0
14	—	40	37.5	11.0	58	4.3
5	—	39	41.5	10.5	49	—
6	—	38.5	36.5	10.7	60	3.6
4	juv.	37.3	43.5	10.7	48	7.2
16a	—	35	40.5	10.9	54	5.1
4	juv.	35	43	10.6	47	7.7
30	—	35	43	12.3	58	4.3
32	—	34.4	40.5	9.9	58	—
14	—	31.8	38.5	9.4	56	—
18	—	25	40	10.0	58	6.0
23c	—	25	42	9.6	62	4.0

## Description

The dorsal mantle-margin projects strongly forward, reaching the mid-level of the eyes; the ventral margin is emarginate. In well-preserved specimens the fins are wide, their anterior ends reaching beyond the lateral mantle-margins, their posterior ends separated and surpassing the posterior end of the mantle. The head is wide; the eyes are very big, but not protruding. The arms are subequal, the ventral ones generally slightly longer than the other ones. All the arms are laterally compressed, the dorsal and lateral ones with a narrow swimming-membrane, the ventral ones with a wide swimming-membrane. The arm-suckers are rather small, quadriserial along the whole length of the arms. The protective membranes are well developed. The interbrachial membrane is well-developed especially between the ventro-lateral and ventral arms, where it attains about one third of the length of the ventral arms; between the latter ones it is absent. The left ventral arm of the male hardly shows any transformation which might be interpreted as a hectocotylization; only in the biggest male, the suckers of the 7th to the 10th transverse rows are slightly smaller than the other ones. The tentacular club is rather short, with a distinct swimming-membrane which extends slightly beyond the base of the club. The well-developed protective membranes are often separated at the base in the young specimens and united

in the larger ones, but this character is very variable. In one specimen they are united but after a short distance again separated. The ventral membrane always continues as a very low, rounded, membranous ridge, sometimes retracted in a very narrow furrow along the whole length of the tentacular stem. When the two membranes are separated, the dorsal one is generally very short, not reaching beyond the swimming-membrane. At the base of the club the two protective membranes come close together but further down the stem become widely separated. The tentacular suckers are arranged in oblique rows of eight, giving the impression that there are only five longitudinal series; those of the second and especially the third series from the dorsal side are distinctly wider than the other ones. The largest tentacular suckers are only slightly wider than the arm-suckers. All the suckers have their chitinous rings armed with numerous very fine denticles, which are highest at the distal sides of the rings. The rings of the tentacular suckers are relatively wider than those of the arm-suckers.

In the largest male specimen, the skin of the dorsal side of the mantle shows a more or less reticulate pattern of fine wrinkles which, near the bases of the fins, form dark longitudinal lines and at the bases of the fins at each side a series of elongate, narrow and low papillae. In this specimen the dorsal sides of the arms show a zebra-like colour-pattern, which is strongly developed on the ventral arms and probably is a secondary sexual character.

The shell is elongate-oval, rather acuminate towards both ends, widest in front of the middle. As the table of measurements shows, there is some variation in the relative width, the small specimens being wider than the larger ones. For the moment it is impossible to state whether the differences in specimens of the same length constitute a sexual character. The dorsal surface is often more or less rose-coloured, especially in its posterior part. There is a median rib, the width of which varies a good deal, and two less defined lateral ribs, separated from the median one by rather flat portions. The anterior part is delicately granulous, the granules partly arranged along the growth-lines and sometimes forming longitudinal lines on the median rib. The posterior part is more strongly rugose, the granules forming an irregular reticulate pattern near the posterior end and radiating ridges in the median portion, often extending on the outer cone. At the bases of the lateral parts of the outer cone the granules form a weak keel separated from the remaining part of the dorsal surface by a groove. The strong spine, devoid of any keels, is straight or slightly turned upwards. The base of the spine is swollen on the dorsal and lateral sides, with a deep radially striated groove on the ventral side and, in large specimens, separated from the dorsal surface of the shell by another groove. In this way, a strong transverse



ridge separates the spine from the dorsal surface. The ventral surface is rather variable. There is always a median sulcus, which is more or less wide and deep along the striated area and continues as a slight depression on the last loculus. The median sulcus is flanked by two rounded ribs at the outer side of which is at each side a less pronounced longitudinal depression. The length of the striated zone is very variable, but the larger shells possess generally a longer striated area than the smaller ones. It is separated from the outer cone by two narrow smooth areas. The inner cone is completely fused to the outer cone, its posterior portion being slightly thicker, surrounding a weak depression. The outer cone forms two long posterior wings. In well-preserved specimens it continues between the inner cone and the spine as a very thin, mostly chitinous wall, which partly covers the ventral depression of the base of the spine.

#### Remarks

Up to the present, the animal of *Sepia novaehollandiae* has never been described. Cotton & Godfrey (1940: 428, fig. 416-417) gave several figures of the animal of *Sepia novaehollandiae*, without mentioning that these figures were copies of the original figures of *Sepia dannevigii* Berry, 1918, which they considered to be a synonym, although, according to the original description, the shell of the latter species was unknown. The above-described animals belong without any doubt to *Sepia novaehollandiae* and the tentacular club proves that *Sepia dannevigii* is certainly a different species, probably synonymous with *Sepia elliptica* Hoyle, 1885 (see p. 165). In fact, the tentacular club of *Sepia dannevigii* has been described as having the 'suckers excessively numerous and minute, in perhaps 10-12 longitudinal series at the middle of the club.'

Cotton (1929: 91) stated that *Sepia irvingi* Meyer, 1909, 'is possibly a variant of *Mesembrisepia novaehollandiae* Hoyle'. According to Adam & Rees (1966: 52) the shell of *Sepia irvingi* seemed to be identical with the shells from Adelaide, which they attributed to *Sepia novaehollandiae*. But if the animals and shells described on page 141 really belong to *Sepia irvingi*, the two species are certainly not synonymous.

Several authors (Iredale, 1926: 190; 1954: 70; Cotton, 1929: 89; Cotton & Godfrey, 1940: 428) have mentioned the resemblance between the shells of *Sepia novaehollandiae* and *Sepia chirotrema* Berry, 1918, which they supposed to be the benthal form of the former species. The description of the animal of *Sepia novaehollandiae* leaves no doubt that these two species are completely different.

'*Mesembrisepia macandrewi*' Iredale, 1926 (p. 191, pl. XXI, fig. 8-9) from New South Wales, which according to the author 'is the Peronian representative of *S. novaehollandiae* Hoyle', does not seem to differ from the latter species, but '*Mesembrisepia ostanes*' Iredale, 1954 (p. 69, pl. IV, fig. 5,6) shows a different general form, the posterior part being relatively wider.

## *SEPIA IRVINGI* MEYER, 1909

(Plate 8, Figs 3-7)

*Sepia irvingi* Meyer, W.Th., 1909: 333, fig. 7-10

Cotton, B.C., 1929: 91

?*Mesembrisepia irvingi* Iredale, T., 1954: 68, pl. IV, fig. 3-4

### Type localities

Cockburn Sound, Garden Island, Port Royal and Warnbro Sound.

### Geographical distribution

Central west coast of Western Australia from Cockburn Sound to Cape Cuvier.

## MATERIAL

### Spirit specimens

- 1 60 km NW of Cape Cuvier, W.A., 156-181 m; July 1972; WAM 875-75:  
2 ♂, 1 ♀ (Plate 8, Figs 3-7).

TABLE 4

Measurements of *Sepia irvingi*.

4a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
1	♂	175	86	41	40	38	42	86	14	40	40	40	46	—	23	1.4	2.3
1	♂	155	86	55	29	—	45	90	13	35	39	45	48	103	23	1.5	2.6
1	♀	150	85	53	27	43	45	93	13	37	40	40	40	—	23	1.5	2.7

4b: Shell (in % of shell-length)

Loc.	Sex	L.in mm	W.	Th.	Str.z.	Spine	Author
1	♂	175	31.5	9.2	63	3.1	
1	♂	155	32	9.7	57	3.2	
1	♀	150	35	9.7	55	3.3	
Type	♀	115	35.5	11.3	67 (fig. 8)		Meyer, 1909: 334
Point Cloates		142	28	11.3			Iredale, 1954: 69
Geraldton		130	31				Iredale, 1954: 69
"		104	35.5				Iredale, 1954: 69
"		78	31				Iredale, 1954: 69
"		62	32				Iredale, 1954: 69
Pelsart Island		173	26				Iredale, 1954: 69

## Description

The mantle-margin is broadly rounded at the dorsal side, slightly emarginate at the ventral side. The broad fins are distinctly separated at the acuminate posterior end of the mantle. The dorsal mantle surface is reddish-purple and shows in both the male specimens at the base of the fins four or five narrow lighter coloured longitudinal bands, separated by larger dark intervals. In the anterior half of the mantle, these bands are followed at the inner side by a rather wide area with a reticulate light-coloured pattern, whereas the remaining part of the dorsal surface is mottled with minute densely crowded light spots on a dark background.

The arms are laterally compressed, keeled at their outer sides, with a well-developed swimming-membrane on the ventral arms. The interbrachial web attains about half the arm-length, except between the ventral arms where it is absent; it is highest between the dorsal arms. The arm-suckers are quadri-serial, the protective membranes wide.

The tentacular club (Plate 8, Fig. 7) strongly resembles that of *Sepia latimanus* and of *Sepia apama* in the sucker-bearing surface being completely surrounded by the protective membranes which are fused at the base, and in the deep groove between the swimming-membrane and the dorsal protective membrane. The groove separates the sucker-bearing surface nearly completely from the stem with which it is connected at the base by a thin membrane which is covered by the basal part of the sucker-bearing surface. The swimming-membrane extends slightly beyond the base of the club. The tentacular suckers seem to be arranged in five longitudinal series, but are in fact arranged in oblique transverse rows of eight, the second and especially the third sucker of each row, starting from the dorsal side, being

larger than the other ones. The chitinous rings of the arm-suckers and tentacular suckers are finely dentate, those of the biggest ones sometimes smooth.

The males do not show any trace of a hectocotylization of the left ventral arm.

The shell of the female is relatively slightly wider than that of the male but otherwise there does not seem to be any sexual difference. The anterior end is very slightly acuminate, more acuminate towards the posterior end; the shell being widest in the anterior half. In the anterior part, the dorsal surface is slightly convex, with a very weak but very broad median rib and two ill-defined lateral ribs. The non-calcified chitinous marginal areas are very large. Towards the posterior end the surface becomes more and more convex. In the anterior part the dorsal surface is finely granulous, the granules being arranged along the growthlines. Near the posterior end the granulation is more pronounced and very characteristic. About at the level of the beginning of the striated zone, the median part of the dorsal surface curves downward and from this point strong keels radiate in all directions, those on the basal portion of the dorsal ribs being less developed than those towards the spine and those situated on the outer cone. The ventral surface is rather flat. The striated area shows a very weak indication of a narrow median groove; the striae are regularly convex. The inner cone is completely fused with the outer cone; its limbs are very narrow and situated at the base of the outer cone, there being no smooth areas between the striated zone and the outer cone. The posterior part of the inner cone, surrounding the weak posterior depression, is a little bit more elongated and attains about the same length as the surrounding part of the outer cone, which separates it from the spine. The latter is rather strong, straight and devoid of keels. Between the base of the spine and the posterior part of the outer cone is a deep groove with strong, calcareous, sharp-edged keels, extending up to the margin of the outer cone.

## Remarks

The original description of *Sepia irvingi* was based on four female specimens, but if the above-described material really belongs to this species, the sex can only be established by opening the mantle, as the male does not show any hectocotylization.

Cotton (1929: 91) stated that *Sepia irvingi* 'is possibly a variant of *Mesembrisepia novaehollandiae* Hoyle'. And speaking about the latter

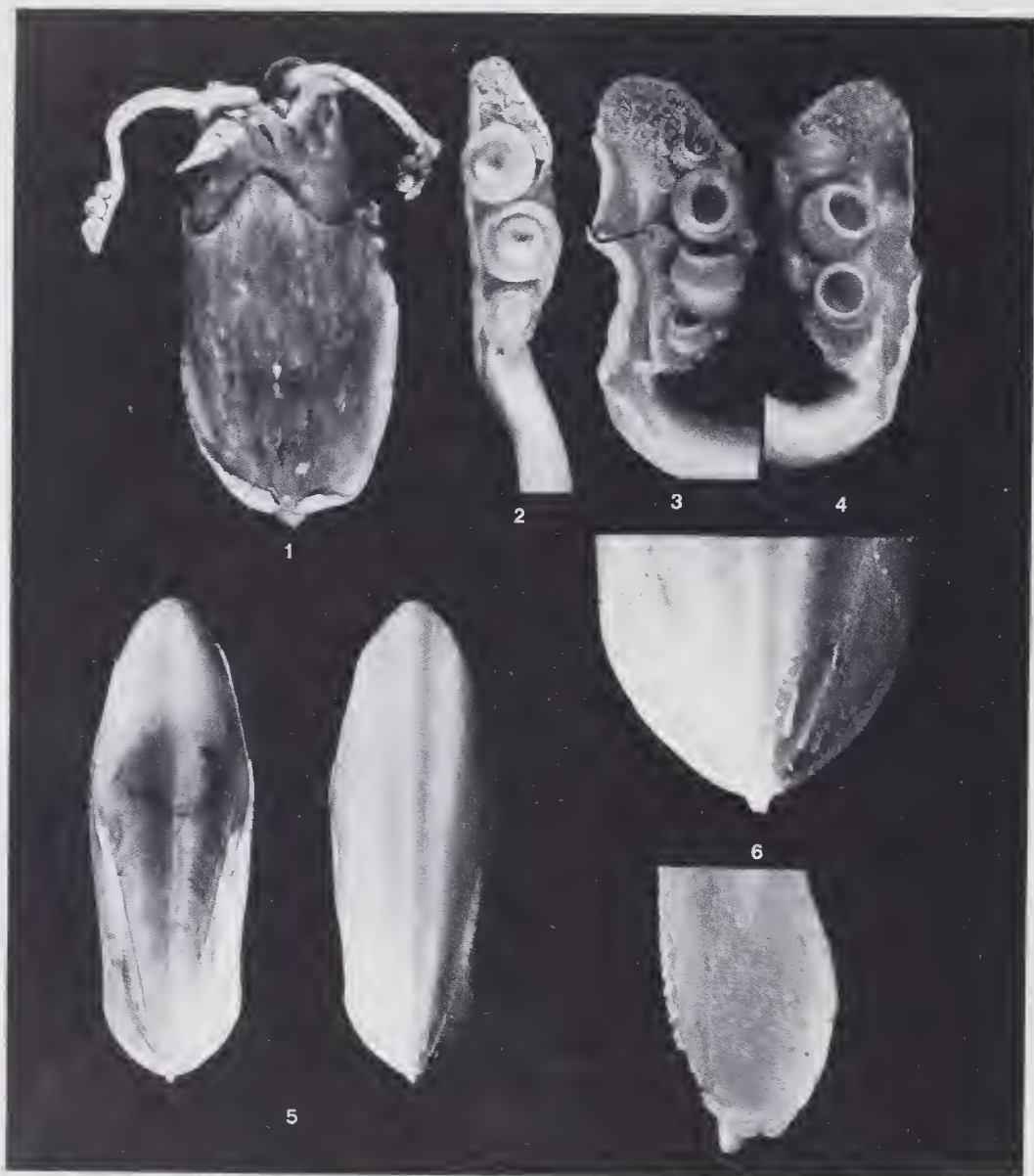


species (p. 89), this author was of the opinion that 'Among hundreds of specimens from South and Western Australia the numerous variants are not separable into any distinct varieties'. But according to Iredale (1954: 69) 'The collections made by Whitley suggest that the Western Australian bones, north of the Swan River, are constant enough, in their narrowness and prominent ventral surface anteriorly, to be admitted as different. Consequently, the western name (*Mesembrisepia irvingi*) may be used for these bones until the matter is decided absolutely by study of animals'. The shell which Iredale (1954: IV, fig. 3,4) figured from Point Cloates as belonging to *Sepia irvingi*, does not differ at all from that of *Sepia novaehollandiae*, but his other references are doubtful.

The above described and figured shells, which we believe to belong to *Sepia irvingi*, differ in many respects from those of *Sepia novaehollandiae*, although there is a certain superficial resemblance. The shell of *Sepia irvingi* is relatively broader and much less acuminate at both ends. The striated area is shorter and the median ventral sulcus very shallow, hardly indicated; the striae being regularly convex and not protruding in the middle. In the original figure of *Sepia irvingi* the foremost striae are slightly protruding; this seems to be the only difference with the above-described specimens. The dorsal surface of the shell of *Sepia irvingi* differs from that of *Sepia novaehollandiae* by the much broader non-calcified marginal areas and especially by the characteristic sculpture of the posterior part, where the median area curves downward at a certain distance from the spine, whereas in *Sepia novaehollandiae* it curves regularly towards the base of the spine (Plate 8, Figs 2, 4 and 5).

The animals of the two species differ principally by their tentacular clubs, those of *Sepia irvingi* being longer and broader with larger suckers and with the protective membranes completely fused at the base, where the sucker-bearing surface is much more detached from the tentacular stem. None of the specimens shows the triangular expansion of the dorsal membrane figured by Meyer (1909: p. 333, fig. 7) which might be an artifact or due to contraction.

It is very interesting that the three specimens of *Sepia irvingi* were collected together with two specimens of *Sepia novaehollandiae*, which proves that the former species is not a local form of the second. Among the numerous shells of *Sepia novaehollandiae* we did not find a single one which resembles *Sepia irvingi*.



# PLATE 1

*Sepia chirotrema* Berry, 1918

Fig. 1: ♀ (M.L.d. = 112 mm), 32°33'S, 115°04'E, W of Mandurah, W.A., 110 m; November 1970, WAM 860-75.

Fig. 2: Idem, left tentacular club (L. = 25 mm).

Fig. 3: ♀ (M.L.d. = 78 mm), left tentacular club (L. = 12 mm), 32°03'S, 114°20'E, W of Rottnest I., W.A., 114-136 m, February 1964, WAM 421-65.

Fig. 4: Idem, right tentacular club (L. = 12 mm).

Fig. 5: Shell of ♀ (Fig. 1) (L. = 112 mm).

Fig. 6: Idem, enlarged details of posterior end of shell (Fig. 5).





## PLATE 2

*Sepia chirostrema* Berry, 1918

Fig. 1: Shell of ♂ (L. = 70 mm), 27°40'S, 113°20'E, NW of Bluff Pt., W.A., 131 m, October 1963, WAM 25-76.

Fig. 2: Idem, enlarged detail of posterior end of shell (Fig. 1).

Fig. 3: Shell of ♀ (L. = 72 mm), same locality as Figs 1-2.

Fig. 4: Idem, enlarged detail of posterior end of shell (Fig. 3).



### PLATE 3

*Sepia chirostrema* Berry, 1918

Fig. 1: Shell of ♂ (?) (L. = 139 mm), Cottesloe Beach, Perth, W.A., July, 1928, WAM 503-76.

Fig. 2: *Idem*, enlarged details of posterior end of shell (Fig. 1).

Fig. 3: Shell of ♀ (?) (L. = 153 mm), Cottesloe Beach, Perth, W.A., September 1927, WAM 502-76.

Fig. 4: *Idem*, enlarged detail of posterior end of shell (Fig. 3).



#### PLATE 4

Fig. 1: *Sepia chirotrema* Berry, 1918: dorsal view of shell (L. = 85.5 mm), Hopetoun, W.A., March 1929, WAM 505-76.

Fig. 2: *Sepia chirotrema* Berry, 1918: juvenile shell (L. = 49.5 mm), Sorrento Beach, Perth, W.A., November 1965, WAM 507-65.

Fig. 3: *Sepia reesi* sp. nov.: Holotype, shell (L. = 45.2 mm), Salmon Bay, Rottnest I., W.A., September 1931, WAM 497-76.

Fig. 4: *Sepia papuensis* Hoyle, 1885: shell of ♂ (L. = 72 mm, 10 km S of Double I. (Barrow I.), W.A., September 1958, WAM 425-65.

Fig. 5: *Sepia papuensis* Hoyle, 1885: right tentacular club (L. = 8 mm) of ♀ (M.L.d. = 69 mm), Shark Bay, W.A., early 1966, WAM 402-76.

Fig. 6: *Sepia smithi* Hoyle, 1885: right tentacular club (L. = 20 mm) of ♂ (M.L.d. = 74 mm), Shark Bay, W.A., early 1966, WAM 398-76.





# PLATE 5

*Sepia cultrata* Hoyle, 1885

Fig. 1: Shell (L. = 110.5 mm), Cottesloe Beach, Perth, W.A., July 1928, WAM 1290-76; February 1928, WAM 1291-76.

Fig. 2: Shell (L. = 78.2 mm), Cottesloe Beach, Perth, W.A., WAM 472-65.

Fig. 3: Shell (L. = 30.6 mm), probably Rottnest I., W.A., WAM 394-76.

Fig. 4: Shell (L. = 18 mm), probably Rottnest I., W.A., WAM 394-76.



# PLATE 6

Fig. 1: *Sepia pharaonis* Ehrenberg, 1831: shell of ♂ (L. = 76 mm), 17°31.5'S, 121°27.0'E, NW of Broome, W.A., 83 m, December 1969, WAM 853-75.

Fig. 2: *Sepia plangon* Gray, 1849: shell (L. = 95.5 mm), Flinders Beach, near Amity, Stradbroke I., Qld, June 1973, WAM 802-75.

Fig. 3: *Sepia rozella* (Iredale, 1926): shell (L. = 106 mm), Flinders Beach, near Amity, Stradbroke I., Qld, June 1973, WAM 809-75.

Fig. 4: *Sepia smithi* Hoyle, 1885: shell (L. = 127 mm), 33 km and 320° from Darwin, N.T., September 1965, WAM 873-75.



# PLATE 7

*Sepia novaehollandiae* Hoyle, 1909

Fig. 1: ♂ (M.L.d. = 132 mm), off Naval Base, Cockburn Sound, W.A., 6 m, August 1958, WAM 415-65.

Fig. 2: Idem, left tentacular club (L. = 25 mm).

Fig. 3: Shell of ♀ (L. = 73 mm), Cockburn Sound, off Rockingham and Kwinana, W.A., February 1970, WAM 866-75.

Fig. 4: Shell (L. = 55.3 mm), Sorrento Beach, Perth, W.A., November 1965, WAM 29-76.

Fig. 5: Shell (L. = 35 mm), same locality as Fig. 4.





#### PLATE 8

Fig. 1: *Sepia novaehollandiae* Hoyle, 1909: Shell of ♀ (L. = 153 mm), 60 km NW of Cape Cuvier, W.A., 155-172 m; July 1972, WAM 876-75.

Fig. 2: Idem, enlarged detail of posterior end of shell (Fig. 1).

Fig. 3: *Sepia irvingi* Meyer, 1909: Shell of ♀ (L. = 150 mm), 60 km NW of Cape Cuvier, W.A., 156-181 m, July 1972, WAM 875-75.

Fig. 4: Idem, enlarged detail of posterior end of shell (Fig. 3).

Fig. 5: Enlarged detail of shell of ♂ (L. = 175 mm), same locality as Figs 3-4.

Fig. 6: Shell of ♂ (L. = 155 mm), same locality as Figs 3-5.

Fig. 7: Right tentacular club (L. = 35 mm) of ♂ (M.L.d. = 155 mm), same locality as Figs 3-6.

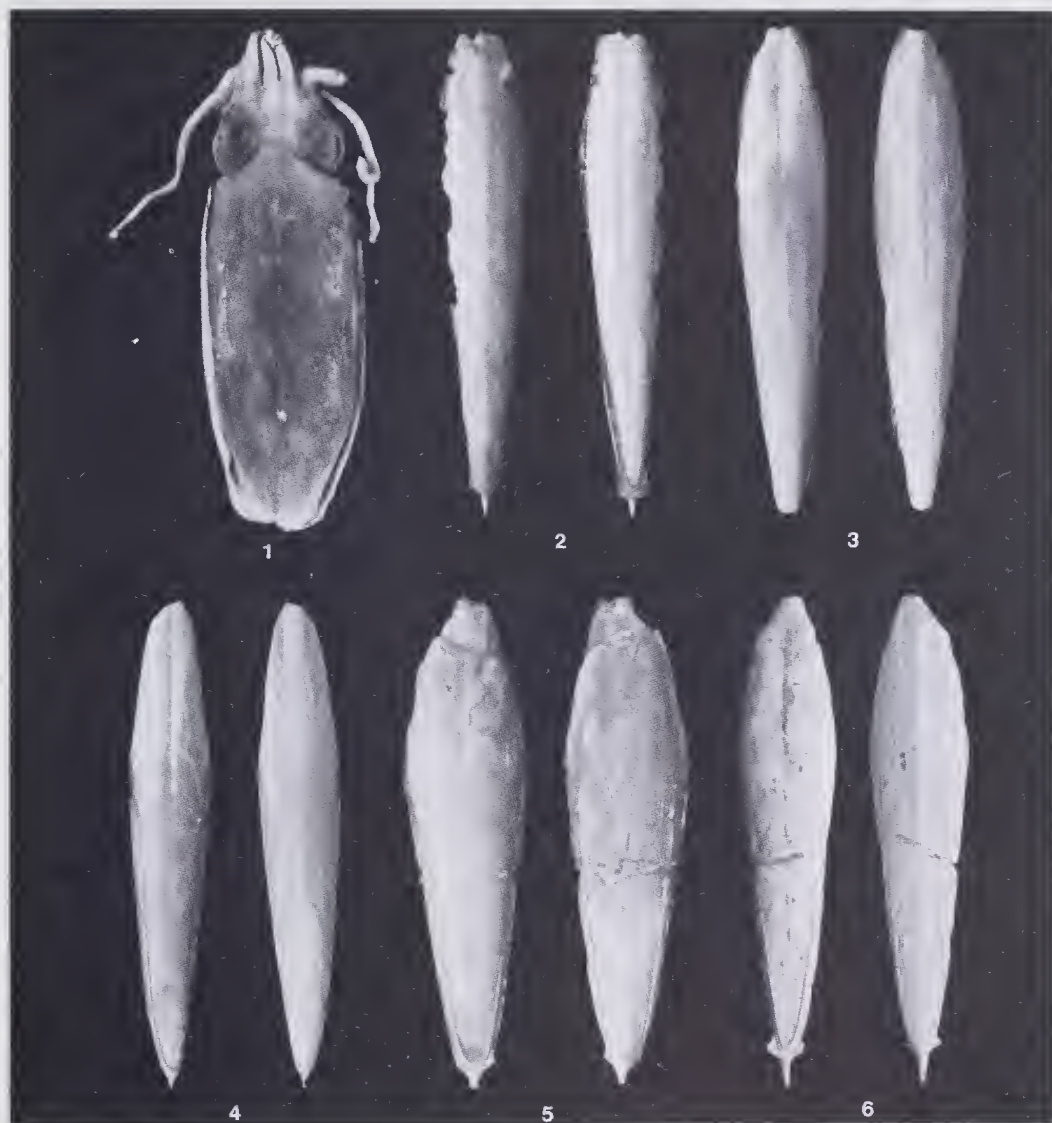


#### PLATE 9

Fig. 1: *Sepia apama* Gray, 1849: shell of juv. spec. (L. = 61 mm), Armstrong Pt., Rottneest I., W.A., March 1958, WAM 423-65.

Fig. 2: *Sepia elliptica* Hoyle, 1885: shell of ♀ (L. = 49 mm), Aru I., Indonesia, June 1971, 2-6 m, WAM 857-75.

Fig. 3: *Sepia mestus* Gray, 1849: shell (L. = 68.2 mm), Flinders Beach, near Amity, Stradbroke I., Qld, June 1973, WAM 810-75.



# PLATE 10

Fig. 1: *Sepia braggi* Verco, 1907: ♀ (M.L.d. = 56 mm), Cockburn Sound, off Rockingham and Kwinana, W.A., February 1958, WAM 871-75.

Fig. 2: *Sepia braggi* Verco, 1907: shell (L. = ± 50 mm), South Australia (Manchester Museum).

Fig. 3: *Sepia braggi* Verco, 1907: shell of ♀ (L. = 58 mm), NE of Rottnest I., W.A., 34 m, September 1965, WAM 437-65.

Fig. 4: *Sepia braggi* Verco, 1907: shell of ♂ (L. = 46 mm), 31°56.8'S, 115°29.4'E to 31°51.8'S, 115°35.3'E, W.A., 38 m, February 1972, WAM 855-75.

Fig. 5: *Sepia vercoi* sp. nov.: shell of ♂ (holotype) (L. = 31 mm), 25°31'S, 112°29'E, W of Shark Bay, W.A., 130 m, October 1963, WAM 441-65.

Fig. 6: *Sepia vercoi* sp. nov.: dry shell (paratype) (L. = 50.5 mm), 24°04'S, 112°59'E, NW of Carnarvon, W.A., 138 m, October 1963, WAM 772-75.

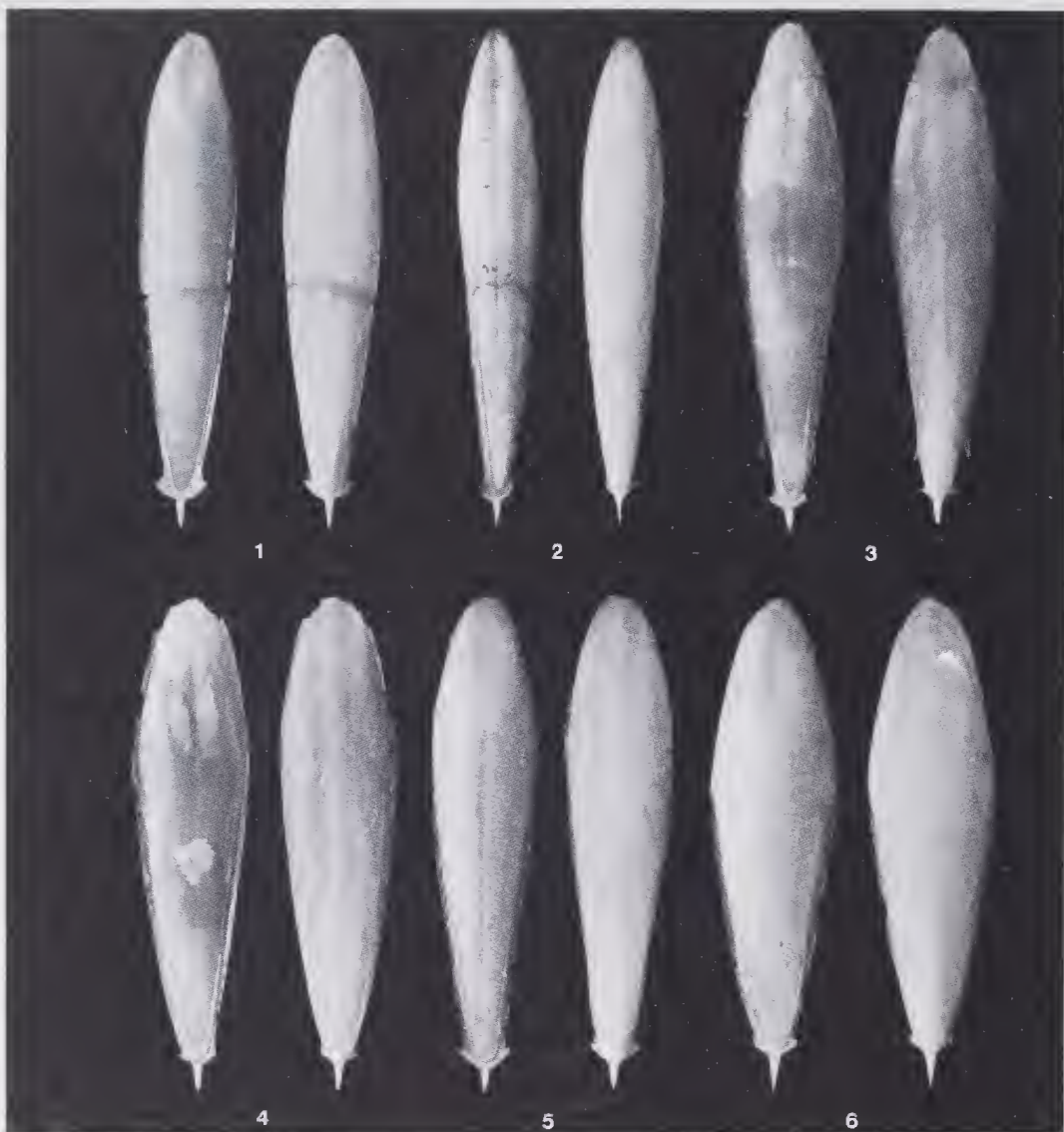


PLATE 11

*Sepia cottoni* sp. nov.

Fig. 1: Shell of ♂ (holotype) (L. = 43.5 mm), 31°05'S, 114°55'E, W of Lancelin W.A., 114-122 m, February 1964, WAM 435-65.

Fig. 2: Shell (L. = 64.6 mm), Cottesloe Beach, Perth, W.A., July 1928, WAM 13595.

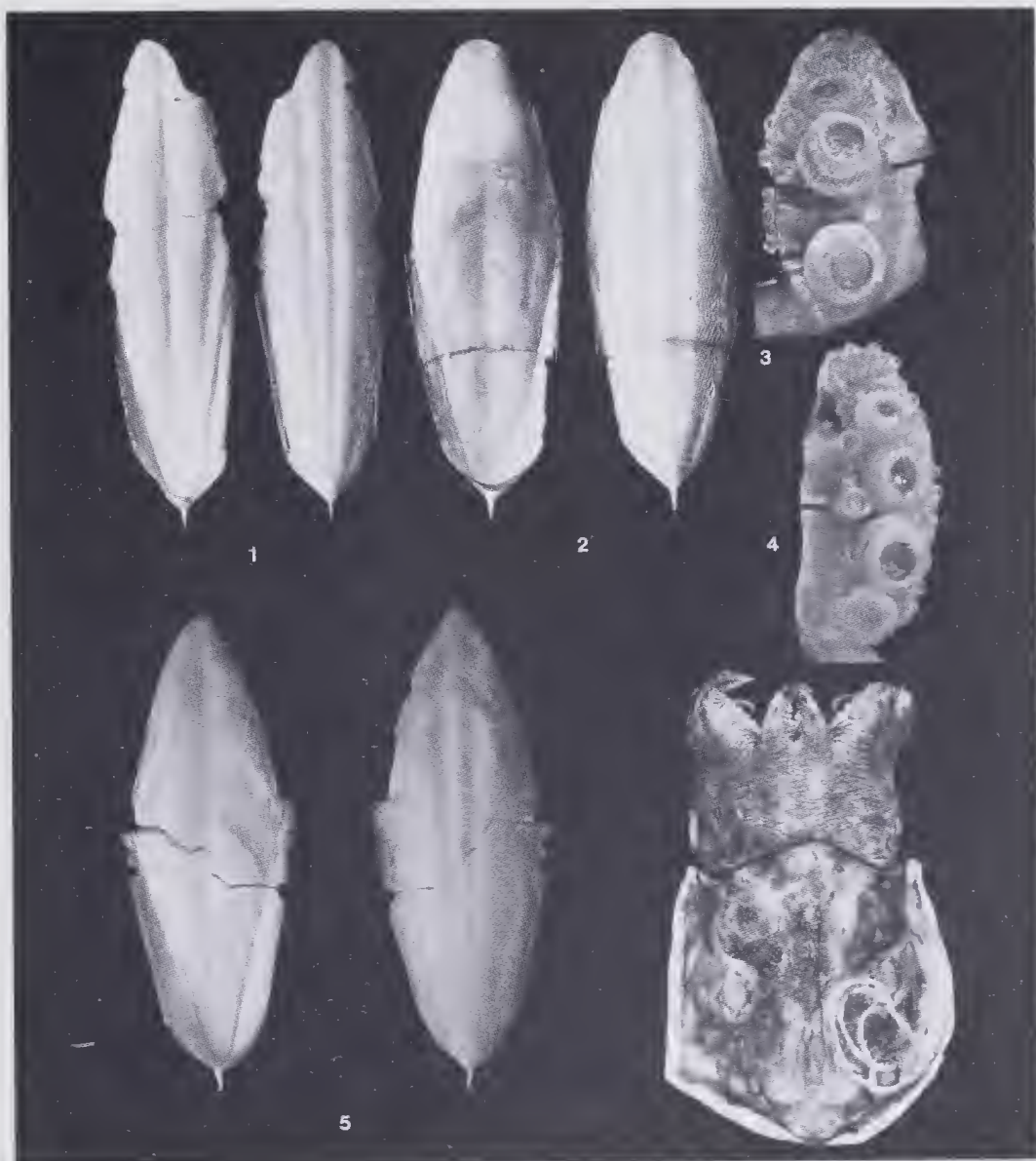
Fig. 3: Shell of ♀ (L. = 43 mm), 27°40'S, 113°20'E, NW of Bluff Pt., W.A., 130 m, October 1963, WAM 424-65.

Fig. 4: Shell of ♀ (L. = 41 mm), 23°39'S, 113°11'E, SW of Pt Cloates, W.A., 134 m, October 1963, WAM 494-76.

Fig. 5: Shell (L. = 34.3 mm), Cottesloe Beach, Perth, W.A., July 1928, WAM 13596.

Fig. 6: Shell (L. = 27.3 mm), Cottesloe Beach, Perth, W.A., July 1928, WAM 13597/13607.





# PLATE 12

Fig. 1: *Sepia rex* (Iredale, 1926): shell (L. = 94 mm), Thevenard I., W.A., WAM 492-65.

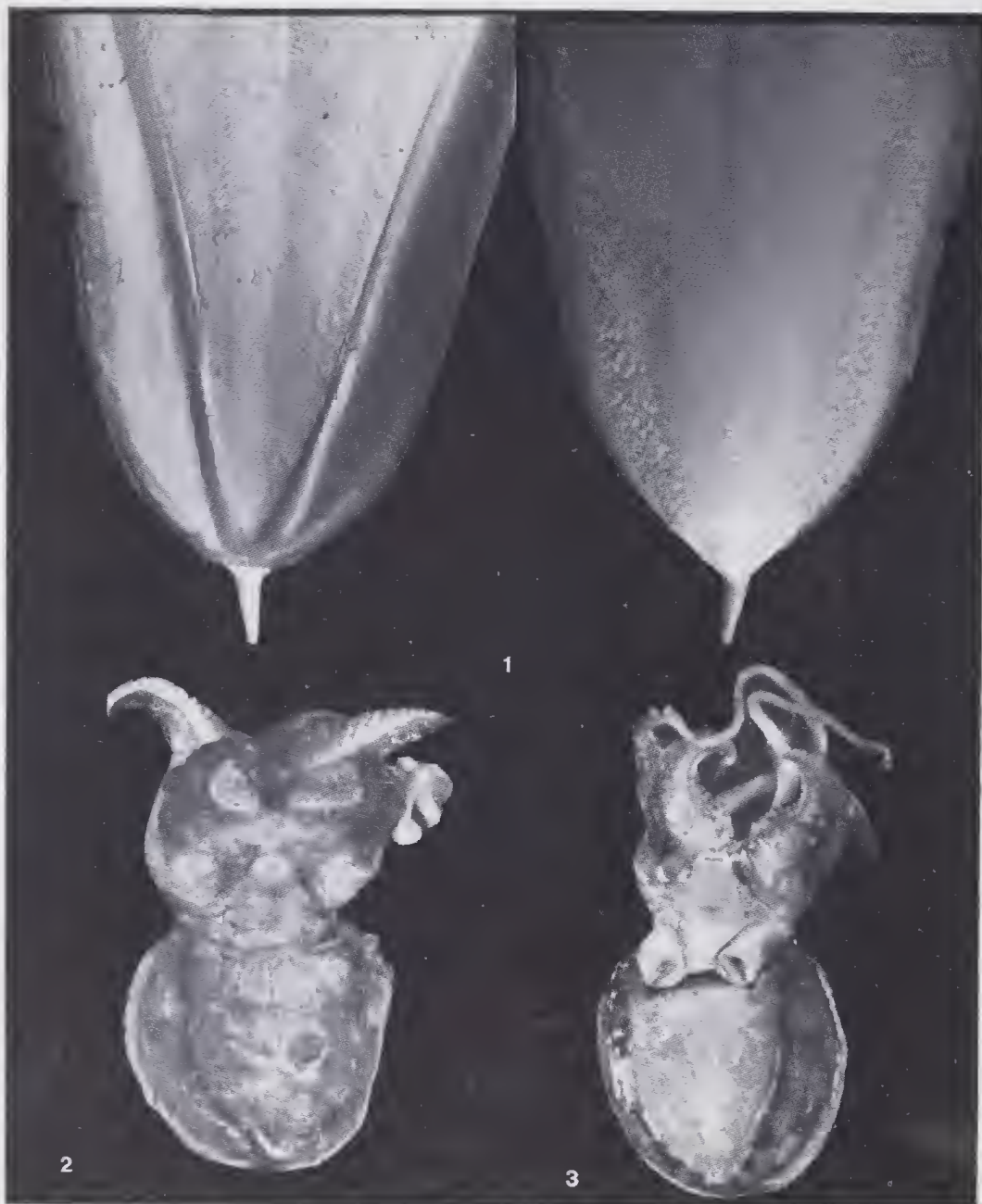
Fig. 2: *Sepia rex* (Iredale, 1926): shell of ♀ (L. = 71 mm), 25°54'S, 112°31'E, W of Dirk Hartog I., W.A., 128-132 m, February 1964, WAM 420-65.

Fig. 3: Idem, right tentacular club (L. = 13 mm) of the same ♀ (Fig. 2).

Fig. 4: Idem, left tentacular club (L. = 13 mm) of the same ♀ (Fig. 2).

Fig. 5: *Sepia jaenschi* (Cotton, 1931): shell (holotype) (L. = 101.9 mm), Robe, S.A.

Fig. 6: *Sepia* (*Metasepia*) *pfefferi* Hoyle, 1885: ♀ (M.L.d. = 44 mm), Shark Bay, W.A., September 1963, WAM 466-65.



### PLATE 13

Fig. 1: *Sepia jaenschii* (Cotton, 1931): enlarged details of posterior end of shell (holotype) (L. = 101.9 mm) (see Plate 12, Fig. 5), Robe, S.A.

Fig. 2: *Sepia* (*Metasepia*) *pfefferi* Hoyle, 1885: ♀ (M.L.d. = 16 mm), SW of Jurien Bay, 30°38'S, 114°47'E, W.A., 110 m, December 1970, WAM 856-75.

Fig. 3: *Sepia* (*Metasepia*) *pfefferi* Hoyle, 1885: ♀ (M.L.d. = 27 mm), W of Mandurah, W.A., 32°33'S, 115°04'E, 110 m, November 1970, WAM 859-75.



*SEPIA CULTRATA* HOYLE, 1885

(Plate 5, Figs 1-4)

*Sepia cultrata* Hoyle, W.E., 1885: 198; 1885a: 303; 1886: 133, pl. XX

Whitelegge, Th., 1889: 282

Brazier, J., 1892: 12

Chapman, F., 1912: 25

Hedley, Ch., 1918: M33

Adam, W. & Rees, W.J., 1966: 58, pl. 17, fig. 99-100

*Sepia capensis* var. Gray, J.E., 1849: 110 (*non* d'Orbigny, 1835)

*Glyptosepia cultrata* Iredale, T., 1926: 192, pl. XXII, fig. 5-6; 1954: 73

Garrard, T.A., 1961: 36

Iredale, T., & McMichael, D.F., 1962: 99

*Glyptosepia macilenta* Iredale, 1926: 192, pl. XXII, fig. 3-4; 1954: 73; 1955: 78-79

*Glyptosepia gemellus* Iredale, T., 1926: 192, pl. XXII, fig. 1-2; 1954: 73

Iredale, T. & McMichael, D.F., 1962: 99

MacPherson, J.H. & Gabriel, C.J., 1962: 409

*Glyptosepia hedleyi* (*non* Berry, 1918), Verco, J.C. & Cotton, B.C., 1928: 127

Cotton, B.C., 1929: 89, pl. XVI, fig. 3-4; 1931: 41, fig. 7-8

MacPherson, J.H. & Gabriel, C.J., 1962: 409

*Sepia* (*Glyptosepia*) *hedleyi* (*non* Berry, 1918), Cotton, B.C. & Godfrey, F.K., 1940: 434, fig. 424 (*non* fig. 422, 423, 425)

### Type localities

Off Twofold Bay, Australia, 36°59'S, 150°20'E (*S. cultrata*); Sydney (*S. capensis* var.); Manly Beach, N.S.W. (*G. macilenta*); Manly Beach, N.S.W. (*G. gemellus*).

### Geographical distribution

Recorded from southern Queensland, New South Wales and Victoria in eastern Australia. In this study the species is recorded at localities between Fremantle and the Houtman Abrolhos in Western Australia.

## MATERIAL

### Dry specimens

- 1 Cottesloe Beach, Perth, W.A.; mixed lot of 25 specimens: July 1928; WAM 1290-76 and February 1928; WAM 1291-76 (Plate 5, Fig. 1).
- 2 Rottnest I.(?), W.A.; (a) WAM 474-65: 5 spec.; (b) WAM 394-76: 5 spec. (Plate 5, Figs 3-4).
- 3 Cottesloe Beach, Perth, W.A.; (a) WAM 472-65: 5 spec. + 1 broken shell (Plate 5, Fig. 2); (b) WAM 395-76: 1 small spec. (identification doubtful).
- 4 Sorrento Beach, Perth, W.A.; November 1965; (a) WAM 396-76: 5 juv. spec. + broken shells; (b) WAM 512-65: 2 spec. + 1 broken shell.
- 5 S of Naval Base Groyne, Cockburn Sound, W.A.; September 1965; WAM 505-65: 2 spec.
- 6 Ocean Beach, Augusta, W.A.; March 1975: WAM 779-75: 1 spec.
- 7 West End, Rottnest I., W.A.; June 1974; WAM 397-76: 3 spec.
- 8 NW side of North I., Houtman Abrolhos, W.A.; August 1974; WAM 787-75: 1 spec.
- 9 No data WAM 469-65: 4 spec.

### Description

The shell is elongate oval, attaining its greatest width in front of the middle; its anterior margin forming a triangle which is short in the small specimens (Plate 5, Figs 3-4) with straight lateral sides and a rounded median angle, but which becomes gradually longer, with concave sides, in the larger specimens (Plate 5, Figs 1-2). The posterior two-thirds of the shell become gradually narrower, forming a rounded posterior angle, which is continued by a strong spine, which is slightly curved upwards and possesses a strong ventral and a strong dorsal keel; sometimes the latter is strongest, sometimes the former. The dorsal surface is cream-coloured or salmon-coloured, rather flat in its anterior part with a more or less distinct, rather narrow median rib and two indistinct lateral ribs; moreover the whole dorsal surface shows numerous faint thread-like longitudinal ribs. In the posterior part, all the ribs become gradually fainter and disappear completely near the spine. There is also a faint granulation, partially arranged along the reversed V-shaped growthlines. On the white dorsal part of the outer cone, the granulation is stronger and forms a more or less reticulate pattern. At each side the outer cone is separated from the remaining part of the dorsal surface by a calcareous ridge.

The ventral surface is rather flat, concave in the extreme posterior part of the striated zone, slightly convex in its anterior part, with at each side, near

the lateral margin, a faint longitudinal depression. The striated area possesses a weak median sulcus in the very small specimens, but it disappears generally in the larger ones, although a very narrow sulcus may subsist; the striae are weakly convex. The last loculus shows a faint median depression and the continuation of the lateral depressions of the striated area. The limbs of the inner cone are narrow and almost completely fused with the outer cone, except in the posterior part where they form a rounded rim surrounding the posterior depression. The outer cone is very narrow in its anterior part, wider in the posterior portion, and continuous between the inner cone and the spine.

There is a good deal of variation in the relative width of the shell and in the shape of the anterior margin; probably the females have a wider shell than the males and the very small shells are much wider than the larger ones.

### Remarks

Although the dry shells seem to be rather common, the present collection from Western Australia did not contain any animals. Adam & Rees (1966: 58) redescribed the female holotype of *Sepia cultrata*. Garrard (1961: 36) mentioned two live specimens of this species, collected east of Newcastle, N.S.W., but unfortunately did not describe them. The above-described shells correspond with the description given by Adam & Rees, which was based on the incomplete shell of the holotype and the shell from Sydney, which J.E. Gray had identified as '*Sepia capensis* var.' and which Hoyle (1886: 136) supposed already to be a variety of *Sepia cultrata*.

On the other hand, the above-described shells belong certainly to the species which Verco & Cotton (1928: 127), Cotton (1929: 89; 1931: 41) and Cotton & Godfrey (1940: 434) identified as *Sepia hedleyi*. Berry (1918: 258, pl. LXXI, LXXII) described the latter species from the following localities: Investigator St. Area, S of Kangaroo I., S.A.; Great Australian Bight; and S of Eucla, Great Australian Bight, W.A. Unfortunately the shell was absent or fragmentary in all the specimens he studied and he could only give a reconstruction of it (pl. LXXII, fig. 2) which certainly resembles that of the type of *Sepia cultrata* and the above-described shells. But *Sepia cultrata* and *Sepia hedleyi* cannot be synonymous, because the animals are different, the former having a tentacular club with small subequal suckers arranged in about five longitudinal series, whereas the second species has much smaller suckers arranged in about twelve series. More animal material is necessary to establish the status of both species, and especially of *Sepia hedleyi*.

TABLE 5  
Measurements of *Sepia cultrata*. Shell (in % of shell-length).

Loc.	L. in mm	W.	Th.	Str.z.	Spine	Loc	L. in mm	W.	Th.	Str.z.	Spine
4b	120	34	8.5	70	8.3	1	90	31	7.2	65	8.9
1	112.7	32	8.0	67	8.0	2a	89.7	33	7.3	67	7.8
5	112.5	32	8.0	70	6.2	1	89	35	8.4	68	8.8
3a	112.3	34	7.7	68	6.4	9	88	33	6.8	67	6.2
5	110.6	34	8.2	67	7.4	1	87.5	32	7.8	66	6.3
1	110.5	34	8.2	68	7.7	9	87	32	7.2	69	7.5
1	110.5	33	8.4	68	6.3	3a	85.4	33	8.2	61	8.2
1	109.5	35	8.9	69	6.9	9	84	35	8.2	70	7.1
1	108.5	36	7.4	69	6.9	1	82.3	32	7.9	65	8.5
3a	108.3	35	8.8	65	6.5	2a	82	34	8.5	67	7.1
1	107.3	34	10.1	63	7.0	2a	82	34	7.9	65	7.1
1	107	34	8.7	65	7.0	1	79.5	34	8.2	65	8.1
9	107	34	8.3	66	7.5	3a	78.2	31	7.9	65	6.3
1	106.6	37	9.7	64	8.0	1	75.5	34	9.3	65	6.0
1	104.8	34	8.6	67	7.1	1	71.3	38	7.7	66	7.7
1	103	34	8.2	67	6.3	6	63	37	8.8	68	—
1	103	33	8.1	68	7.8	3a	58.4	37	8.6	58	6.3
1	101	37	9.4	66	6.4	2b	30.6	47	10.8	62	4.9
1	100.7	31	7.9	64	7.4	7	28	50	8.9	68	3.6
1	100.4	30	7.9	66	8.1	2b	26	46	10.8	61	—
1	100	34	10.7	65	7.8	4a	24.8	48	9.3	60	—
2a	98	35	8.7	69	7.1	2b	24.5	48	13.0	61	—
8	97	37	9.3	65	8.2	2b	23.5	47	9.8	64	—
2a	91.3	33	7.9	66	5.9	4a	19	53	7.9	68	—
1	91	34	8.0	69	7.1	2b	18	53	11.6	61	—
4b	91	37	9.9	68	5.5	7	17.5	53	12.6	60	—
1	90	40	11.0	70	—	3b	14	57	11.4	64	—

TABLE 6

Measurements of the species of *Glyptosepia*, given by Iredale (1954: 72-74)

<i>S. hedleyi</i>		<i>S. gemellus</i>		<i>S. gemellus</i> <sup>1</sup> (Betka River mouth)		<i>S. macilenta</i>		<i>S. opipara</i>	
L. in mm	W. (%)	L. in mm	W. (%)	L. in mm	W. (%)	L. in mm	W. (%)	L. in mm	W. (%)
120	34	109	32	98	33.5	92	30.5	169	27
116	33.5	104	33.5	98	33.5	79	33	151	30
115	35.5	96	36.5	92	35	75	34.5	132	32
110	35.5	95	36	91	36	60	40	68	32.5
107	36.5	90	38	85	31.5	17	53	63	30
106	36.5			85	36.5			56	34
84	31			80	31.5				
44	34			78	32				
				77	36.5				
				77	32.5				
				76	33				
				75	33				
				74	32.5				
				64	34.5				
	31-36.5%		32-38%		31.5-36.5%		30.5-53%		27-34%

1) About these specimens, Iredale (1954: 73) states that they appear referable to *gemellus* and that the figures agree 'fairly well with those of a typical series, but also suggesting the later suppression of *macilenta*'.



Iredale (1926: 191) created a new genus, *Glyptosepia*, for species without an inner cone and without a ventral sulcus. In the descriptions of the three new species *G. opipara*, *G. gemellus* and *G. macilenta*, this author repeats these characters, but the figures (pl. XXII, fig. 7-8, fig. 1-2 and fig. 3-4) show an inner cone and a ventral sulcus. As to the first character, there does not exist a single species of *Sepia* without an inner cone. As to the ventral sulcus, many of the above-described specimens show a very narrow and shallow median groove and it is possible that in the figures of Iredale's species, this groove has been exaggerated by the artist.

*Sepia opipara* and *Sepia gemellus* have been described (Iredale, 1926: 191 and 192) as being about twice as long as broad, whereas according to the above-mentioned measurements (Table 6), given by the author himself (1954: 72-74), the width varies between 27 and 34% of the length in *Sepia opipara*, and between 31.5 and 38% in *Sepia gemellus*. Iredale (1954: 73) compared *Sepia gemellus* and *Sepia hedleyi* (*sensu* Cotton) and stated about the latter species: 'It will be noted that all these bones are larger and broader than the broadest eastern shells of *gemellus*'. This statement is again in contradiction with his own figures, as he gives the width of the shells of *Sepia hedleyi* as being 31-36.5% of the length.

Under *Sepia macilenta* he mentions a possible sexual difference in the proportions: 'On this subject it may be noted that when *hedleyi* was proposed on animals, no distinct characters for separating the sexes were indicated, and the broad bone was taken from a male. It should be added that this form approaches nearest the missing *cultrata* in proportions, but *cultrata* was almost as narrow, and it was from a female.' In fact Berry (1918: 259) described the hectocotylized arm of *Sepia hedleyi*, and the reconstructed shell (pl. LXXII, fig. 2) was of a female specimen with a dorsal mantle-length of 91 mm. According to the original figure, the width of this shell is 35% of the length. Iredale (1954: 73) concludes his observations with the following statement: 'So until animals are well studied it is best to allow *cultrata* to remain in suspense, and use *hedleyi*, *gemellus* and *macilenta*, noting the far west *hedleyi* have larger and broader bones'. This statement is not substantiated by his own figures. Iredale (1955: 79) arrived at the conclusion, speaking about *Sepia cultrata*: 'the type bone did not essentially disagree with the variety, and both are undoubtedly the local shell which I named *macilenta*, so that *cultrata* can be reinstated, and *macilenta* dropped as a synonym of *Glyptosepia cultrata*'. 'This still leaves unresolved the status of *gemellus*, which agrees closely but is a broader shell, even as the southern and western *hedleyi*'.



According to Adam & Rees (1966: 59) 'The original figures of *Glyptosepia macilenta* Iredale (1926: 192, pl. XXII, fig. 3 & 4) represent an entirely different species, which cannot be considered to be identical with *Sepia cultrata*.' After having examined the numerous shells which belong certainly to *Sepia hedleyi* as several Australian authors understood this species, I believe, as mentioned above (p. 160) that the original figure of the ventral surface of the shell of *Sepia macilenta* does not give an exact idea of this species and that, in fact, *Sepia macilenta* is a synonym of *Sepia cultrata*. On the other hand, a comparison of the numerous above-described shells with Iredale's figures of *Sepia gemellus* and *Sepia macilenta*, does not permit a specific separation of these three species.

As to '*Glyptosepia opipara* Iredale, 1926', I cannot give an opinion about its status without having seen any material. According to Iredale (1954: 72) 'This beautiful bone is so far only known from Queensland, drifted bones from New South Wales as far south as Sydney, and Lord Howe Island. It is one of the most brittle of all bones, the majority being broken. It is easily recognisable by its form, its strongly sculptured back and its deep dorsal coloration, with its long spine.'

## *SEPIA ELLIPTICA* HOYLE, 1885

(Plate 9, Fig. 2)

*Sepia elliptica* Hoyle, W.E., 1885: 189; 1885a: 293; 1886: 131, pl. XIX, fig. 14-24

Brazier, J., 1892: 13

Massy, A.L., 1916: 226

Adam, W., 1939: 72

Adam, W. & Rees, W.J., 1966: 14, pl. 5, fig. 24-27; pl. 43, fig. 258

*Acanthosepion (Fiscisepia) ellipticum adjacens* Iredale, T., 1926a: 239, pl. XXXV, fig. 5-6; 1954: 77

Iredale, T. & McMichael, D.F., 1962: 99

*Acanthosepion ellipticum* Iredale, T., 1954: 77

?*Acanthosepion whitleyanum* Iredale, T., 1926: 195, pl. XXIII, fig. 9-10; 1954: 76

Iredale, T. & McMichael, D.F., 1962: 99

?*Sepia whitleyana* Adam, W. & Rees, W.J., 1966: 16, pl. 6, fig. 28-29

?*Sepia dannevigii* Berry, S.S., 1918: 264, text fig. 51-55, pl. LXXIII; pl. LXXIV, fig. 1-2

## Type localities

Challenger Sta. 188, 9°59'S, 139°42'E, Arafura Sea, S of Papua, 28 fms [green mud], 10-IX-1874; Challenger Sta. 190, 8°56'S, 136°5'E, Arafura Sea, S of Papua, 49 fms [green mud], 12-IX-1874 (*Sepia elliptica*); North-west Islet (subsp. *adjacens*); Port Macquarie, N.S.W. (*Sepia whitleyana*); Investigator Strait area, S of Kangaroo Island, S.A. (*Sepia dannevigii*).

## Geographical distribution

Indo-West Pacific; northern Australia southwards to at least the Exmouth Gulf area in Western Australia and southern Queensland (Capricorn Group) on the east coast. (If the names *S. whitleyana* and *S. dannevigii* are correctly placed in the synonymy then the species' range must include New South Wales, South Australia and the southwestern coast of Western Australia.)

## MATERIAL

### Spirit specimens

- 1 Aru Is, Indonesia, 2-6 m, mud bottom; June 1971; WAM 857-75: 1 ♀ (Plate 9, Fig. 2).
- 2 Joseph Bonaparte Gulf, W.A. (13°43.5'S, 128°38.6'E), 62 m; December 1969; WAM 872-75: 3 ♀.
- 3 Joseph Bonaparte Gulf, W.A. (13°54.8'S, 128°33'E), 52 m; December 1969; WAM 874-75: 2 ♀, 1 ♂.

### Dry specimens

- 4 Onslow Beach, W.A.; September 1958; WAM 489-65: 3 spec.
- 5 Thevenard I., W.A.; WAM 493-65: 3 spec.
- 6 Passage I. in Mary Ann Passage, S of Barrow I., W.A.; September 1958; WAM 495-65: 4 spec.
- 7 Barrow I., W.A.; September 1958; WAM 497-65: 1 spec.
- 8 Pasco I., S of Barrow L., W.A. (20°55'S, 115°20'E); August 1966; WAM 774-75: 1 spec.
- 9 Cockatoo I., W.A.; August 1968; WAM 775-75: 1 spec.
- 10 Cape Wessel, Northern Territory; WAM 777-75: 2 spec.
- 11 Coburg Peninsula(?), Northern Territory; WAM 778-75: 4 spec.
- 12 Kendrew I., Dampier Arch., W.A. (20°28'30"S, 116°32'E); 1973; WAM 841-75: 17 spec.

TABLE 7  
Measurements of *Sepia elliptica*.

7a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a	S.t.
3	♂	71	91	56	38	30	49	91	14	42	49	49	58	180	22.5	1.8	0.6
3	♀	84	82	—	—	39	51	95	12	36	36	42	48	140	21.5	1.4	0.5
3	♀	78	86	56	33	36	49	94	13	38	42	42	49	—	—	1.5	—
2	♀	75	88	—	—	29	41	88	8	40	47	47	49	160	20	1.6	0.5
2	♀	72	83	64	29	25	49	93	12	49	44	44	47	—	21	1.7	0.6
2	♀	60	88	55	32	41	—	90	10	42	50	50	50	—	21.5	1.7	0.5
1	♀	49	86	51	37	33	47	96	10	33	33	33	41	82	16	1.6	0.4

7b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
6	—	106.5	41	9.5	71	3.3	12	—	76	43	9.9	68	5.3
4	—	106	42	8.7	70	3.3	12	—	75	41	9.3	61	5.3
5	—	104.5	42	9.1	70	3.8	2	♀	75	45	11.4	59	4.0
6	—	101.4	43	9.9	73	3.2	8	—	74.5	42	8.7	71	5.4
7	—	96	43	9.4	67	—	5	—	73	43	10.7	59	5.5
5	—	95	40	8.8	—	3.7	11	—	72.5	42	8.3	69	4.8
6	—	91.4	45	9.3	68	3.8	2	♀	72	43	11.1	58	4.2
12	—	90	42	9.1	74	4.4	12	—	72	44	9.7	61	4.2
12	—	85	43	9.4	74	—	3	♂	71	41	10.6	69	—
3	♀	84	45	11.4	64	3.6	12	—	71	39	8.5	73	5.6
10	—	84	44	8.9	71	4.8	4	—	70	42	10.3	66	5.0
12	—	83.5	42	9.0	76	4.8	12	—	70	41	10.0	60	5.0
12	—	82	43	9.9	67	—	12	—	70	46	10.0	60	5.0
6	—	80	39	9.1	71	3.7	12	—	66	42	9.1	63	4.5
3	♀	78	42	10.5	64	3.8	12	—	66	41	9.1	71	6.1
12	—	78	44	9.6	67	—	11	—	62.5	41	8.8	67	4.8
10	—	77.5	44	9.7	70	5.1	2	♀	60	44	10.3	60	—
11	—	77.5	45	10.8	68	5.1	12	—	60	42	9.2	60	5.0
12	—	77	44	9.7	71	3.9	1	♀	49	42	9.2	57	5.1
12	—	77	43	10.4	62	5.2	9	—	46	46	10.4	56	6.5
4	—	76.4	44	9.7	64	3.9							

## 7c: Literature records

Loc.	L. in mm	W. (%)	Reference
North-west I., Qld	105	44	Holotype <i>Sepia elliptica adjacens</i> (Iredale, 1926a: 239)
Melville Island	99	43.5	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Melville Island	98	43	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Melville Island,	97	38	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Melville Island	47	42.5	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Low Island, Qld	106	41.5	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Low Island, Qld	101	44.5	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Low Island, Qld	99	45.5	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Low Island, Qld	49	47	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Broome, W.A.	80	46	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Broome, W.A.	80	44	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Broome, W.A.	68	47	<i>Sepia elliptica</i> (Iredale, 1954: 77)
Port Macquarie, N.S.W.	168	38.5 <sup>1</sup>	Holotype <i>Sepia whitleyana</i> (Iredale, 1926: 195)
Bribie Island, Qld	235	33	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	114	37	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	102	40	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	90	38	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	50	42	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	43	47.5	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	34	53 <sup>2</sup>	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	30	46.5	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Michaelmas Cay	26	38.5	<i>Sepia whitleyana</i> (Iredale, 1954: 76)
Caloundra, Qld	89	42	? <i>Sepia whitleyana</i> (Adam and Rees, 1966: 16)

<sup>1</sup> In the original description, Iredale (1926: 195) states that the dimensions of the holotype are 168 x 65 mm; in his later description (1954: 76) he mentions them as being 168 x 56 mm. Compared with the original figure (pl.XXIII, fig. 9-10) the former statement seems to be the correct one.

<sup>2</sup> Owing to a typographical error, Adam and Rees (1966: 17) cited this width as 47%.

## Description

The animals correspond with the original description, with the exception of the tentacular club, which as Adam & Rees (1966: 15) stated, is covered with 10 to 12 longitudinal series of minute suckers. In the larger specimens the protective membranes are fused at the base of the club, but in the smaller ones they seem to be separated; the state of preservation does not always allow a decision. As in the male types, the hectocotylus has seven or eight transverse rows of normal suckers at the base, followed by about seven rows of transformed suckers, the ventral ones being only slightly smaller while the dorsal ones are considerably smaller than the normal ones.

The shells are typical and show especially the characteristic posterior part of the inner cone, which is raised as a flat, rather thin ledge, with a thickened rim from which radiate a few ribs towards the outer cone (Plate 9, Fig. 2).

## Remarks

Adam & Rees (1966: 16) have discussed the status of this species and the differences between it and *Sepia esculenta* Hoyle, 1885. The latter species seems to attain a much larger size, which may explain certain differences, but much more material of both species is needed to establish their relationship.

In the same paper, Adam & Rees (1966: 16, pl. 6, fig. 28, 29) described and figured a shell from Caloundra, which Cotton had identified as *Sepia whitleyana* (Iredale, 1926). This shell does not differ at all from the above-mentioned shells of *Sepia elliptica*. In fact I do not believe that this shell belongs to *Sepia whitleyana*. The latter species seems to be more closely related to *Sepia smithi* Hoyle, 1885, and may even be a synonym of this species; a decision is only possible by the study of the original material of Iredale's species.

As to *Sepia dannevigii* Berry, 1918, the shell of which is unknown, the author stated (p. 267) that 'in most characters, with the exception of the unknown cuttlebone, it stands apparently nearest to *S. elliptica*. They can scarcely be identical, however, since the latter is not only from a different faunal area, but is described as having subequal arms and only eight series of tentacular suckers, the horny rings of which are smooth.' In fact, the arm length may vary a good deal owing to contraction during preservation; *Sepia elliptica* has also ten to twelve series of tentacular suckers, and the latter have their chitinous rings dentate as in *Sepia dannevigii*. The only difference seems to be the geographical distribution and the unknown shell. Only the collection of topotypical material can solve the problem.

### *SEPIA SMITHI* HOYLE, 1885

(Plate 4, Fig. 6; Plate 6, Fig. 4)

*Sepia smithi* Hoyle, W.E., 1885: 190; 1886: 21, 124, pl. 16, fig. 1-12

Brazier, J., 1892: 11

Adam, W., 1939: 78

Adam, W. & Rees, W.J., 1966: 19, pl. 7, fig. 34-35; pl. 41, fig. 239

*Acanthosepion smithi* Iredale, T., 1954: 77

*Acanthosepion pageorum* Iredale, T., 1954: 76, pl. IV, fig. 7-9

*Sepia pageora* Adam, W. & Rees, W.J., 1966: 20, pl. 7, fig. 36-37; pl. 42, fig. 253

*Sepia indica* Gray, J.E., 1849: 108 (*non* d'Orbigny, 1848)



### Type localities

Challenger Sta. 188, 9°59'S, 139°42'E, Arafura Sea, S of Papua, 10-IX-1874, 28 fms [green mud], (*Sepia smithi*); Keppel Bay, Queensland (*Sepia pageora*).

### Geographical distribution

Northern Australia and New Guinea; southwards to Shark Bay in Western Australia and Keppel Bay in Queensland.

## MATERIAL

### Spirit specimens

- 1 Shark Bay, W.A.; early 1966; WAM 398-76: 1 ♂ (Plate 4, Fig. 6).
- 2 33 km and 320° from Darwin, N.T.; September 1965; WAM 873-75: 4 spec. (Plate 6, Fig. 4).

### Dry specimens

- 3 Onslow Beach, W.A.; September 1958; WAM 488-65: 3 spec.
- 4 Lowendahl I., NNE of Onslow, W.A.; WAM 490-65: 1 spec.
- 5 Thevenard I., N of Onslow, W.A.; WAM 400-76: 1 spec.
- 6 Passage I., Mary Ann Passage, S of Barrow I., W.A.; September 1958; (a) WAM 494-65: 1 spec.; (b) WAM 401-76: 1 spec.
- 7 South Pasco I., S of Barrow I., W.A. (20°55'S, 115°20'E); August 1966; WAM 399-76: 2 spec.
- 8 Barrow I., W.A.; August-September 1966; WAM 776-75: 1 spec.
- 9 Flinders Beach near Amity, Stradbroke I., Qld; June 1973; WAM 780-75: 1 spec.
- 10 Kendrew I., Dampier Arch., W.A. (20°28'30"S, 116°32'E); (a) November 1974; WAM 845-75: 1 spec.; (b) February 1974; WAM 847-75: 1 spec.; (c) 1973; WAM 848-75: 3 spec.

### Description

Of the five spirit specimens only the young male from Shark Bay (Loc. 1) is well preserved. It agrees with the syntypes of *Sepia smithi*, redescribed by Adam & Rees (1966: 19) and with the male specimen from Cape Upstart, which these authors mentioned under *Sepia pageora*. As the specimen from Shark Bay is smaller than the one from Cape Upstart, a slight difference in the hectocotylus may be attributed to its youth. In fact the first specimen has only six transverse rows of smaller suckers, which in each row are grouped in two marginal pairs, the ventral suckers being smaller than the dorsal ones.



TABLE 8

Measurements of *Sepia smithi*

8a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.cl.	S.a.	St.
1	♂	74	91	50	35	31	40	96	12	34	34	34	34+	27	1.5	0.5

8b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
7	—	165	33	7.0	80	3.0	9	—	110	39	8.7	72	3.6
4	—	147	35	9.1	73	5.4	10c	—	105	35	7.6	73	4.3
6b	—	145 <sup>+</sup>	37	7.3	78	3.8	3	—	102	34	6.9	74	4.9
3	—	135	35	8.6	77	4.3	2	?	100	32	7.0	76	4.5
7	—	132	37	7.2	77	3.0	6a	—	99	36	6.8	71	4.3
3	—	131.2	37	8.0	74	4.0	10b	—	90	36	6.7	67	4.4
10a	—	130	37	8.0	72	—	10c	—	90	36	7.2	71	5.6
2	?	126	34	7.5	78	—	10c	—	74	40	8.1	70	—
5	—	121	36	7.7	71	4.1	1	♂	72	39	7.5	68	4.9
2	?	114	38	8.3	80	—	2	?	66.5	40	9.8	63	4.5
8	—	111	35	7.4	77	3.6							

Loc.	L. in mm	W. (%)	Reference
Lindeman I., Qld	146	35	<i>pageora</i> (Iredale, 1954: 76)
Point Cloates, W.A.	140	36	<i>pageora</i> (Iredale, 1954: 76)
Keppel Bay, Qld	135	37	<i>pageora</i> (Iredale, 1954: 76) (Holotype)
Lindeman I., Qld	124	34	<i>pageora</i> (Iredale, 1954: 76)
Timor Sea	120	33	<i>pageora</i> (Iredale, 1954: 76)
Bucasra Beach, Qld	110	39	<i>pageora</i> (Iredale, 1954: 76)
Lindeman I., Qld	90	37	<i>pageora</i> (Iredale, 1954: 76)
Shark Bay, W.A.	60	42	<i>pageora</i> (Iredale, 1954: 76)
Lindeman I., Qld	58	41	<i>pageora</i> (Iredale, 1954: 76)

### Remarks

Without examining the shells, the animals of *Sepia smithi* and *Sepia elliptica* may be easily confused, because of the minute tentacular suckers, but in the former species the tentacular club is relatively much longer, its protective membranes are widely separated at the base and the numerous suckers are disposed in about 20 longitudinal series (Plate 4, Fig. 6), whereas in *Sepia elliptica* the protective membranes are fused at the base of the club and the less numerous suckers are arranged in 10 to 12 series in the middle of the club.

Compared with that of *Sepia elliptica*, the shell of *Sepia smithi* (Plate 6, Fig. 4) is much narrower, the striated area longer and the striae more angular in the anterior portion, the posterior ridge of the inner cone is thicker and rounded, not flattened, and the limbs of the inner cone are situated at the lateral limits of the striated zone, and not in the middle of the smooth marginal areas between the striated zone and the outer cone.

After having studied the above-mentioned material, we do not hesitate any more to consider *Sepia pageora* as a synonym of *Sepia smithi*.

As mentioned on p. 165, *Sepia whitleyana* (Iredale, 1926) seems to be closely related to *Sepia smithi*.

### SEPIA PAPUENSIS HOYLE, 1885

(Plate 4, Figs 4-5)

*Sepia papuensis* Hoyle, W.E., 1885: 197; 1886: 126, pl. 16, fig. 13-23

Brazier, J., 1892: 11

Joubin, L., 1897: 102

- Appelöf, A., 1898: 561  
 Adam, W., 1939: 85  
 Voss, G.L., 1963: 35  
 Adam, W. & Rees, W.J., 1966: 38, pl. 12, fig. 68-69; pl. 42, fig. 250  
*Sepia prionota* Voss, G.L., 1962a: 169; 1963: 24, pl. I, fig. f-g; text fig. 1a-e  
 Adam, W. & Rees, W.J., 1966: 41, pl. 4, fig. 22-23; pl. 42, fig. 252  
*Solitosepia occidua* Cotton, B.C., 1929: 88, pl. XIV, fig. 1-2  
*Sepia occidua* Adam, W. 1939: 85, pl. I, fig. 5  
*Sepia galei* Meyer, W.Th., 1909: 332, fig. 4-6  
*Solitosepia submestus* Iredale, T., 1926: 238, pl. XXXV, fig. 3-4; 1954: 65  
 ?*Solitosepia genista* Iredale, T., 1954: 66, pl. V, fig. 17-18  
 ?*Solitosepia lana* Iredale, T., 1954: 66

#### Type localities

Challenger Sta. 188, 9°59'S, 139°42'E, Arafura Sea, S of Papua, 28 fms [green mud], (*S. papuensis*); off Sirun I., Sulu Archipelago, Tawi Tawi Group (*S. prionota*); Rottnest I. (*S. occidua*); Shark Bay, near Brown Station on Dirk Hartog (*S. galei*); Masthead Island (*S. submestus*); Broome, W.A. (*S. genista*); Low Isles, Queensland (*S. lana*).

#### Geographical distribution

Central Indo-West Pacific (Arafura Sea, Philippines, Ternate, Bali); northern Australia southwards to Fremantle in Western Australia and perhaps on the east coast (if *S. lana* is considered as a synonym).

### MATERIAL

#### Spirit specimens

- 1 120 km NW of Bedout I., W.A., 96 m; October 1962; WAM 419-65: 1 ♂.
- 2 10 km S of Double I., Barrow I., W.A.; September 1958; WAM 425-65: 1 ♂ (Plate 4, Fig. 4).
- 3 W of Rottnest I., W.A. (32°00'S, 115°08'E), 137 m; August 1963; WAM 429-65: 1 juv. spec. (M.L.d. 7 mm).
- 4 W of Kalbarri, W.A. (27°40'S, 113°20'E), 131 m; October 1963; WAM 442-65: 1 juv. spec. (M.L.d. 24 mm) (doubtful identification).

- 5 1 km SW of Doc Can I., Laparan Group, Sulu Arch., Philippines, 56 m; February 1964; WAM 444-65: 1 juv. spec. (M.L.d. 24.5 mm).
- 6 Shark Bay, W.A.; early 1966; WAM 402-76: 2 ♂, 1 ♀ (Plate 4, Fig. 5).
- 7 Monte Bello Is, W.A.; May 1973; WAM 870-75: 1 ♂.

#### Dry specimens

- 8 Rottnest I.(?), W.A.; WAM 496-76: 2 spec. + 3 broken shells.
- 9 Cottesloe Beach, Perth, W.A.; WAM 478-65: 2 spec.
- 10 Onslow Beach, W.A.; September 1958; WAM 488-76: 4 spec.
- 11 Lowendahl I., NNE of Onslow, W.A.; WAM 491-65: 1 spec.
- 12 Thevenard I., N of Onslow, W.A.; WAM 489-76: 1 spec.
- 13 Barrow I., W.A.; September 1958; WAM 496-65: 3 spec.
- 14 Sorrento Beach, Perth, W.A.; November 1965; WAM 509-65: 5 spec. (4 broken).
- 15 Salmon Bay, Rottnest I., W.A.; September 1931; WAM 820/23-31: 4 spec.
- 16 South Passage, Shark Bay, W.A.; March 1963; WAM 785-75: 3 spec.
- 17 Turtle Bay, East Wallabi I., Houtman Abrolhos, W.A.; April 1974; WAM 801-75: 1 spec.
- 18 Coburg Peninsula (?), Northern Territory; WAM 803-75: 2 spec.
- 19 South Pasco I., S of Barrow I., W.A. (20°58'S, 115°20'E); August 1966; WAM 804-75: 3 spec.
- 20 Cape Wessel, N.T.; WAM 805-75: 2 spec.
- 21 Barrow I., W.A.; September 1966; WAM 806-75: 1 spec.
- 22 Kendrew I., Dampier Arch., W.A. (20°28'30"S, 116°32'E); (a) October 1974; WAM 842-75: 1 spec., (b) May 1973; WAM 843-75: 1 spec., (c) February 1974; WAM 844-75: 3 spec.; (d) WAM 846-75: 1 spec.

#### Description

The male specimens of localities 1 and 2 are in a rather poor condition and cannot be properly measured, but those of localities 6 and 7 are better preserved as well as the young specimens from the other localities. Even the very small specimen of locality 3 (with a dorsal mantle-length of 7 mm), shows very distinctly the character, which Voss (1962: 169; 1963: 24) mentioned for *Sepia prionota*: the swimming-membranes of the dorsal, dorso-lateral and ventro-lateral arms bearing a series of semicircular, more or less elongated lappets. In some cases these lappets descend on the dorsal side of the swimming-membrane in its proximal half. In well-preserved specimens smaller papillae cover the dorsal and ventral surfaces of the mantle

TABLE 9  
Measurements of *Sepia papuensis*

9a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
7	♂	64	81	53	27	31	42	84	12	38	36	36	39	117	14	1.7	1.4
6	♂	59	83	44	34	24	39	88	10	31	31	31	36	93	15	2.2	1.5
6	♂	51	88	47	31	29	41	84	10	25	25	31	39	79	10	2.0	1.4
6	♀	69	85	43	30	27	33	89	10	30	—	40	—	94	12	—	1.4

9b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
19	—	100	33.5	8	67	3	7	♂	63	35	7.9	60	4.8
22c	—	90	33.5	8.3	70	4.4	22a	—	63	33	7.9	67	—
22c	—	88	35	8.2	73	4.5	6	♂	57	31.5	7.0	61	3.5
12	—	84.7	32.5	7.7	65	—	8	—	52.7	36	8.2	59	—
10	—	83.5	33.5	6.7	61	—	20	—	50.5	37.5	7.5	57	5.9
19	—	83	35	6.7	69	3.6	20	—	50	38	8.6	62	5.0
13	—	82.4	33	7.3	61	—	15	—	46	39.5	8.7	61	—
22b	—	81	34.5	7.4	68	—	14	—	45.9	40	8.1	61	—
10	—	79.5	32.5	7.5	63	—	15	—	45	40	8.2	58	—
21	—	77.5	32	7.1	70	3.9	15	—	43.8	38	8.0	61	—
13	—	73	33.5	8.1	60	—	17	—	43	38	9.3	58	7.0
2	♂	72	33.	7.5	64	—	8	—	39.7	42	9.3	60	—
11	—	72	33	7.2	62	—	15	—	39.6	38	8.8	63	—
13	—	70.5	34.5	8.1	60	—	9	—	39.3	40.5	7.9	60	—
22c	—	70	38.5	8.1	64	—	9	—	39	39.5	8.2	59	—
10	—	69	33.5	7.3	66	—	5	juv.	24.5	46	11.0	57	—
6	♀	67	34	7.7	63	—	4	juv.	24	46	9.2	57	—
19	—	67	35	7.4	70	3.0							

## 9c: Literature records

Species	Sex	L. in mm	W. (%)	Author
<i>S. papuensis</i>	♂	63	35	Adam & Rees, 1966
<i>S. papuensis</i>	—	71	34	Iredale, 1954
<i>S. papuensis</i>	—	70	34	Iredale, 1954
<i>S. papuensis</i>	—	68	35	Iredale, 1954
<i>S. papuensis</i>	—	64	36	Iredale, 1954
<i>S. prionota</i>	♀	61	34	Voss, 1963-Type
<i>S. prionota</i>	♀	35	42	Voss, 1963
<i>S. galei</i>	—	80	34	Meyer, 1909-Type
<i>S. galei</i>	—	110	34	Iredale, 1954
<i>S. galei</i>	—	38	34	Iredale, 1954
<i>S. occidua</i>	—	48	40	Cotton, 1929-Type
<i>S. occidua</i>	—	72.3 <sup>+</sup>	39	Adam, 1939
<i>S. occidua</i>	—	68.4	37	Adam, 1939
<i>S. occidua</i>	—	68	38	Iredale, 1954
<i>S. occidua</i>	—	49	39	Iredale, 1954
<i>S. submestus</i>	—	68	35	Iredale, 1926-Type
<i>S. submestus</i>	—	89	36	Iredale, 1954
<i>S. submestus</i>	—	74	38	Iredale, 1954
<i>S. submestus</i>	—	24	38	Iredale, 1954
<i>S. submestus</i>	—	24	42	Iredale, 1954
<i>S. genista</i>	—	67	34	Iredale, 1954-Type
<i>S. genista</i>	—	69	32	Iredale, 1954
<i>S. genista</i>	—	59	39	Iredale, 1954
<i>S. genista</i>	—	46	35	Iredale, 1954
<i>S. lana</i>	—	99	37	Iredale, 1954-Type

and the dorsal and lateral surfaces of the head and the arms, but they are lacking on the ventral surface of the head and of the ventral arms. According to Adam & Rees (1966: 39) these papillae in *Sepia papuensis* did not have any special taxonomic value. This may be true for adult specimens, which are not well enough preserved, but the typical lappets on the keels of the arms, especially in young specimens, seem to be a specific character, which has not been described in any other species. Voss (1963: 24) only mentioned female specimens of *Sepia prionota*, but as in *Sepia papuensis* the males do not show any trace of hectocotylization on the left ventral arm, it is not impossible that some of his specimens were males. The presence of a female specimen in the above-mentioned material proves that there exists nevertheless another secondary sexual character in the males. In fact the latter have their lateral and especially their dorsal arms effiliated at the tips. On the



distal parts of these arms the suckers change gradually their quadriserial arrangement in a biserial one. First the median suckers become smaller than the marginal ones and finally disappear completely, whereas the marginal suckers persist but become very minute and may also disappear on the extreme tips of the dorsal arms. In the female all the arms are simply acuminate with quadriserial suckers throughout, and not effiliated.

In the young specimen (Loc. 5, M.L.d. = 24.5 mm) the protective membranes of the tentacular club are separated at the base of the club, the dorsal one extending much further on the stem than the ventral one. But in the larger specimens these membranes are fused, the ventral membrane becoming attached to the dorsal one.

The larger shells are characterized by the wide, well limited mid-dorsal rib, and by the thick chitinous ledge formed by the posterior part of the fused outer and inner cones.

The very young shells differ a good deal from the adult ones. They are relatively wider and thicker, with a shorter striated zone. The dorsal surface shows only a faint indication of the beginning of the broad median rib. The striated zone is rather narrow, flanked by two broad smooth marginal zones, which persist in the later stages. The broad limbs of the inner cone are completely fused with the outer cone, but the posterior part is slightly raised, surrounding the posterior depression. The posterior part of the outer cone is narrow and does not yet show the chitinous ledge, which is characteristic for larger specimens. The anterior end of the shell is slightly acuminate, less rounded than in larger specimens.

#### Remarks

I have nothing to add to the discussion by Adam & Rees (1966: 39) of the relationship of *Sepia papuensis* with other species. I consider *Sepia prionota*, *S. occidua*, *S. galei* and *S. submestus* as synonyms of *Sepia papuensis*. As to *Sepia lana* and *Sepia genista* their status cannot be established without having seen the original material, but they may also be synonyms of *Sepia papuensis*.

### *SEPIA PHARAONIS* EHRENBERG, 1831

(Plate 6, Fig. 1)

*Sepia pharaonis* Ehrenberg, C.G., 1831: ?

Adam, W., 1941: 5, pl. II, fig. 1; 1959: 130, fig. 2, pl. I-III, IV, fig. 3; 1960: 3; 1973: 10

- Voss, G.L., 1963: 20, pl. I, fig. b-c; text fig. 1f, g  
Adam, W. & Rees, W.J., 1966: 22, pl. 8, fig. 38-43; pl. 41, fig. 240  
Voss, G.L., & Williamson, G., 1971: 23, pls 1-4, figs 4, 7, 8
- Sepia rouxii* Férussac, A. de & Orbigny, A. d', 1841: 271, pl. 19  
Adam, W., 1939: 56, pl. I, fig. 4; pl. II, fig. 6-7  
Satyamurti, S.T., 1956: 179, pl. XXVI, fig. 3
- Acanthosepion rouxi* Rochebrune, A.T. de, 1884: 108  
Adam, W., 1944: 232
- Sepia torosa* Ortmann, A., 1888: 652, pl. XXIII, fig. 2  
Sasaki, M., 1929: 163, fig. 100-101; pl. XVI, fig. 11  
Adam, W., 1939: 61
- Sepia framea* Ortmann, A., 1891: 675, pl. XLVI, fig. 2  
Adam, W., 1939: 62
- Sepia singalensis* Goodrich, E.S., 1896: 3, pl. I, fig. 4-8  
Adam, W., 1939: 62
- Ascarosepion singhalensis* var. *foxi* Robson, G.C., 1927: 325
- Sepia koettlitzii* Hoyle, W.E. & Standen, R., 1901: 1, pl. I  
Adam, W., 1939: 63
- Sepia formosana* Berry, S.S., 1912: 420, fig. 2, pl. IX, fig. 7  
Sasaki, M., 1929: 165, fig. 165-166, pl. XXX, fig. 9-11  
Adam, W., 1939: 64
- Crumenasepia hulliana* Iredale, T., 1926a: 239, pl. XXXV, fig. 1-2; 1954: 77
- Sepia hulliana* Adam, W., 1939: 65
- Sepia tigris* Sasaki, M., 1929: 168, fig. 167, pl. XXVIII, fig. 13-16  
Adam, W., 1939: 65
- Crumenasepia ursulae* Cotton, B.C., 1929: 90, pl. XV, fig. 3-4
- Sepia ursulae* Adam, W., 1939: 66
- Sepia (Crumenasepia) ursulae* Cotton, B.C. & Godfrey, F.K., 1940: 434, fig. 421
- ?*Sepia venusta* Pfeffer, G., 1884: 12, fig. 15, 15a  
Hoyle, W.E., 1905: 982 (*non* Münster, 1837)
- ?*Sepia venustoides* Hoyle, W.E., 1909: 266 ( = *Sepia venusta* Pfeffer, *non* Münster, 1837)
- Sepia sinope* Voss, G.L., 1962: 3 (*non* Gray, 1849)

### Type localities

Tor, Sinai; Massaouah (*S. pharaonis*); Bombay; Red Sea (*S. rouxii*); Tokyo Bay (*S. torosa*); Ceylon (*S. framea*); Colombo; off Point de Galle (*S. singalensis*); Zeila, nearly opposite to Aden (*S. koettlitzii*); Takao, Formosa (*S. formosana*); Howick Island, N. Queensland (*S. hulliana*); Taihoku market, Formosa (*S. tigris*); Cottesloe, Rottnest Island (*S. ursulae*); Kabret; Port Taufiq (*S. singalensis* var. *foxi*); Zanzibar (*S. venusta*); Manila market (*S. sinope* Voss, non Gray).

### Geographical distribution

Indo-West Pacific; northern Australia southwards to Cape Le Grande in Western Australia and Masthead I., Capricorn Group, Queensland, on the east coast.

## MATERIAL

### Spirit specimens

- 1 Shark Bay, W.A.; March 1962; WAM 427-65: 2 spec. (damaged).
- 2 NW of Broome, W.A. (17°31.5'S, 121°27'E), 83 m; December 1969; WAM 853-75: 1 ♂, 1 ♀ (Plate 6, Fig. 1).
- 3 Monte Bello Is, W.A.; May 1973; WAM 493-76: 1 ♀.

### Dry specimens

- 4 Cottesloe Beach, Perth, W.A.; (a) July 1937; WAM 186-37: 1 spec. (L. > 270 mm); (b) WAM 564-31: 1 spec.; (c) July 1931; WAM 584-31: 1 spec. (L. > 260 mm); (d) July 1931; WAM 586-31: 1 spec.
- 5 No data; (a) WAM 483-65: 3 spec.; (b) WAM 485-65: 4 spec. (broken); (c) WAM 486-76: 2 spec. (broken).
- 6 Back Beach, Geraldton, W.A.; September 1974; WAM 827-75: 2 spec.
- 7 Coburg Peninsula(?), N.T.; WAM 828-75: 1 spec. (damaged).
- 8 Cape Le Grande, W.A.; January 1973; WAM 830-75: 1 spec.
- 9 Kendrew I., Dampier Arch., W.A. (20°28'30"S, 116°32'E); (a) May 1973; WAM 840-75: 1 spec.; (b) February 1974; WAM 849-75: 1 spec.; (c) February 1974; WAM 850-75: 4 spec. (3 incomplete).

### Description

The above-mentioned material does not differ from previous descriptions (see Adam & Rees, 1966: 22). The young male specimen (M.L.d. = 76 mm) shows only the beginning of the transformation of the hectocotylus.

TABLE 10  
Measurements of *Sepia pharaonis*

10a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
3	♀	155	86	48	33	23	35	94	9.7	35	39	39	42	—	26	1.6	2.9
2	♂	76	89	53	33	29	43	92	6.6	37	37	37	45	200	26	1.6	2.4
2	♀	53	89	60	26	30	41	94	9.4	34	38	38	43	—	—	1.5	—

10b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
6	—	195	36	10.8	59	4.6	6	—	130	37.5	10.4	64	4.6
8	—	190	37	11.0	58	4.7	9b	—	101	35.5	9.4	60	4.0
9c	—	182	35	9.2	77	3.8	2	♂	75	37.5	8.0	61	—
4b	—	161	35	10.8	56	6.2	2	♀	52	38.5	7.7	58	—
5a	—	144	34.5	9.7	58	4.2	1	?	50	37.5	8.4	58	—
5a	—	137	35	10.2	58	5.8	4d	—	43	40.5	9.3	53	4.2
5a	—	132	36	9.8	56	5.3							

## SEPIA REX (IREDALE, 1926)

(Plate 12, Figs 1-5; Plate 13, Fig. 1)

*Decorisepia rex* Iredale, T., 1926: 193, pl. XXII, fig. 9-10; 1954: 72  
Garrard, T.A., 1961: 36

Iredale, T. & McMichael, D.F., 1962: 99

MacPherson, J.H. & Gabriel, C.J., 1962: 409

?*Sepia capensis* Chapman, F. (*non* d'Orbigny, 1835), 1912: 24, pl. I.

*Decorisepia jaenschii* Cotton, B.C., 1931: 41, fig. 5-6

*Sepia* (*Decorisepia*) *jaenschii* Cotton, B.C. & Godfrey, F.K., 1940: 439,  
fig. 427

*Sepia jaenschii* Adam, W. & Rees, W.J., 1966: 55, pl. 16, fig. 93-94

?*Decorisepia cottesloensis* Cotton, B.C., 1929: 90, pl. XVI, fig. 1-2

?*Sepia* (*Decorisepia*) *cottesloensis* Cotton, B.C. & Godfrey, F.K., 1940:  
438, fig. 426

### Type localities

Manly Beach, N.S.W. (*S. rex*); Torquay, Victoria (*S. capensis*); Robe,  
S.A. (*S. jaenschii*), Cottesloe, W.A. (*S. cottesloensis*).

### Geographical distribution

All Australian States including Lord Howe Island; here recorded from  
localities from Shark Bay to Thevenard I. on the northwestern coast of  
Western Australia.

## MATERIAL

### Spirit specimens

- 1 W of Dirk Hartog I., W.A. (25°54'S, 112°38'E), 128-132 m; February  
1964; WAM 420-65: 2 ♀, 1 ♂ (Plate 12, Figs 2-4).
- 2 SW of Point Cloates, W.A. (23°39'S, 113°11'E), 134 m; October  
1963; WAM 495-76: 1 ♂, 1 juv. spec.
- 3 W of Shark Bay, W.A. (25°31'S, 112°29'E), 130 m; October 1963;  
WAM 485-76: 2 juv. spec. (M.L.d. 14 mm and 31 mm).
- 4 Off W coast of W.A.; 1963; WAM 447-65: 1 ♂, 1 juv. spec.

### Dry specimen

- 5 Thevenard I., N of Onslow, W.A.; WAM 492-65: 1 spec. (Plate 12,  
Fig. 1).

TABLE 11  
Measurements of *Sepia rex*.

11a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
1	♀	71	±76	±41	21	35	75	5.6	35	35	35	35	85	18	2.1	4.7
1	♀	55	69	42	22	33	76	—	36	33	33	36	145	18	2.2	4.7
1	♂	66	±75	±38	23	38	76	7.6	38	38	38	38	91	20	2.3	4.7

11b: Shell (in % of shell-length)

Loc.	Sex	L.in mm	W.	Th.	Str.z.	Spine
5	—	94	26.5 <sup>+</sup>	8.7	71	4.3
1	♀	71	32.5	8.7	61	5.6
1	♂	66	32	8.3	62	4.5
2	♂	44	34	7.7	57	4.5
4	♂	32.5	38.5	8.3	61	6.1
2	juv.	21.2	45	8.5	54	4.7

### Description

The mantle is elongate-oval but it is impossible to give exact measurements of the largest specimens owing to their strong contraction after fixation. The dorsal mantle-margin is strongly protruding, surpassing the mid-level of the eyes; the ventral margin is very slightly emarginate. The dorsal arms are slightly keeled at the outer side, the other ones have a distinct swimming-membrane, which, on the ventral arms descends on the ventral side of the head. The sectors of the interbrachial web are low and subequal, absent between the ventral arms. The tentacles are very long and slender, with a relatively short club (Plate 12, Figs 3-4). The swimming-membrane is well-developed and extends for a short distance beyond the base of the club. The protective membranes are well-developed, especially the ventral one, which is very wide and thin. These membranes are not fused at the base of the club. The latter bears in the middle a series of four, occasionally five, big suckers, the second one being the largest. These suckers are situated each in a deep pit, the dorsal wall of which has an opening through the protective membrane. These pits are separated by transverse membranes, which bear at the dorsal side a small lateral sucker and a very small marginal sucker; at the ventral side a small lateral sucker and four minute marginal suckers, two at the proximal side and two at the distal side of the lateral sucker. At the base of the club are eight small



suckers and at the distal end 25-30 small suckers. The chitinous rings of the globular arm-suckers, which are quadriserial, the median ones larger than the marginal ones, are smooth. Those of the small tentacular suckers are finely dentate. The left ventral arm of the male is hectocotyized and possesses at its base two or three transverse rows of normal suckers, followed by ten rows of much smaller suckers, which in each row are arranged in two pairs of widely spaced suckers, the ventral ones being smaller than the dorsal ones.

The shell is elongate oval, widest a little in front of the middle, and bluntly acuminate at both ends. The relative width decreases with the size, the small shells being much wider than the greater ones. The rose-coloured or salmon-coloured dorsal surface shows three strong longitudinal ribs, separated by two rather narrow grooves. In the posterior part a lesser furrow is situated at each side at the base of the outer cone. The whole dorsal surface, except the rather narrow chitinous outer cone, is granulous, the granules following partly the growthlines, but forming an irregular reticulate pattern on the lateral portions. The extreme posterior area, near the spine, is smooth and glossy. The spine is slightly directed upwards, with a strong dorsal and a weaker ventral keel. The ventral surface is rather flat, with a narrow median groove over its whole length. The striae are slightly convex in the posterior part, more and more reversed V-shaped towards the last loculus. The median groove is flanked by two low, wide ribs, flanked in their turn at each side by a narrow, shallow, lateral groove, which is separated from the outer cone by a narrow rib. The inner cone has very narrow, obsolete limbs, fused with the outer cone, and a slightly raised and rounded posterior rim, surrounding the slightly excavated posterior portion of the striated area. The outer cone is somewhat enlarged in its posterior part, forming two calcareous wings, united by the chitinous membrane between the spine and the inner cone; the whole forming a cup-like formation as in *Sepia papuensis* Hoyle and *Sepia plangon* Gray.

### Remarks

It is after much hesitation that I have identified the above-described material as *Sepia rex* Iredale. The animal of this species has never been described, although Garrard (1961: 36) reported two live specimens from east of Lake Macquarie. Although Iredale (1926: 193) described this species as having 'no inner cone and no ventral sulcus', his figure (pl. XXII, fig. 10) shows both and strongly resembles the figures of the present material (Plate 12, Figs 1-2). Unfortunately a final decision about the status of this species is impossible; Mrs S.M. Slack-Smith kindly informed me (pers. comm. 11-VIII-1975) that according to Dr Ponder of the Australian Museum

in Sydney the type of '*Decorisepia rex*' cannot be found. 'As with many of Iredale's types, it might have been stored in the general collection and is now lost or without distinguishing label'. As the type is a dry shell and as cuttlebones can float for a long time and be transported over large distances, it is impossible to collect topotypical material. Iredale described the spine as being rounded and does not mention any keels, but these might have been worn. In 1954 (p. 72) he spoke again about this species and stated that 'similar shells have been named *jaenschi* from western Victoria and South Australia, and another shell from Rottnest Island, Western Australia, *cottesloensis*'. (In fact the latter species came from Cottesloe.) He states also: 'As noted under *Mesembrisepia macandrewi*, bones from north Tasmania and east Victoria agree completely with typical specimens of *Decorisepia rex*, and at present cannot be separated'. In fact it is under '*Mesembrisepia ostanes*' (p. 69) that he speaks about these specimens. On p. 72, he further mentions that 'Chapman recorded *capensis* from Torquay, Victoria, fortunately giving a figure, so it is recognisable as *Decorisepia rex*'. In fact the figure which Chapman (1912: 24, pl. I) gives of a species which he believed to be *Sepia capensis* d'Orbigny, does not show the slightest resemblance with *Sepia rex*, but on p. 70, under '*Mesembrisepia ostanes*', Iredale mentions that he has seen the specimens recorded by Chapman, and that the 'plesiotype' of *capensis* is also *Decorisepia rex*.

As to *Sepia jaenschi*, Adam & Rees (1966: 55, pl. 16, fig. 93-94) described and figured a specimen from Robe, South Australia, which had been identified by Cotton himself. This specimen, which was rather damaged, exactly resembles the dry shell from Thevenard Island, northwestern Australia, which was also damaged (see Plate 12, Fig. 1), except that the spine did not show any keels, which might have been worn. Fortunately the type of *Sepia jaenschi* still exists and Mrs S.M. Slack-Smith was kind enough to send me photographs (see Plate 12, Fig. 5; Plate 13, Fig. 1) and a detailed description of this type, which had been lent to her by the South Australian Museum. According to this description of the holotype, the spine is 'oval in cross section', which may indicate that it had been keeled, otherwise, the cross section would have been round. The dorsal surface has a median rib, which is 'well marked and bordered by moderately deep sulci'; the lateral ribs are 'less obvious than the median rib but obvious from about 1.5 cm anterior to spine tip'. As to the sculpture: 'very fine granular surface (pink) except for white areas extending on either side from about 0.5 cm before base of spine — these areas have opaque white vermiculate sculpture and overlie outer cone — medially to these white areas are two vague areas (more yellowish pink than is remainder of dorsal surface) which have slightly stronger granular sculpture than does rest of median section of dorsal surface: this area lies over edges of striated area and inner

cone limbs. Behind termination of lateral limbs of inner cone the slightly heavier granulation extends along sides of shell and over posterior tip — the base of spine is smooth and unsculptured and has a ventral extension surrounded by edge of outer cone'. The ventral surface has a 'median depression, shallow — best marked in central third of shell — lateral zones narrow and extending only just posterior to area of greatest width of shell, i.e. about 1 cm long. Inner cone cream in colour — very slightly hollow under posterior angle — posterior border slopes down over base of spine — lateral limbs raised to form slight hollow for about 0.7 cm in front of angle — extend to about point of greatest width of shell — becoming less well marked about 3.7 cm anterior to angle of inner cone. Outer cone appears thin around anterior half of shell — expands posterior to poorly marked waste (which is about 2.6 cm from spine tip) — surrounds inner cone posteriorly, forming a vertical shelf below base of spine.' The holotype has a total length of 10.19 cm and a width of 3.7 cm (36.5%) whereas the above mentioned shell from Robe, identified by Cotton, had a length of 112 mm and a width of 28.5+%, and the one from Thevenard Island, a length of 94 mm and a width of 26.5+%, but both the latter specimens were damaged and their real width was certainly much greater. The figured shell (Plate 12, Fig. 2) of the largest female specimen (L. = 71 mm) is a little less acuminate, but the other specimens have the anterior end acuminate as in the type of *Sepia jaenschii*, although they are not as broad as the latter, taking into account that the smaller shells have generally wider shells.

*Sepia cottesloensis* (Cotton, 1929), based on a shell of only 42.6 mm had a width of 43%. I have not seen a single specimen of this species among the numerous shells studied for the present report. It may be a juvenile specimen of *Sepia jaenschii*.

If the above described material really represents *Sepia rex*, which I cannot prove in absence of the holotype, but what I believe to be the case, I consider *Sepia jaenschii* and probably also *Sepia cottesloensis* as synonyms of the former species.

It is noteworthy that the animal strongly resembles *Sepia prashadi* Winckworth, 1936 and *Sepia omani* Adam & Rees, 1966 by the tentacular clubs and by the hectocotyli, but the shells are completely different (see Adam & Rees, 1966); without examining the latter it would be practically impossible to identify these three species. *Sepia prashadi* has been reported from Madras (shells), Mauritius (shells), Madagascar (shells), Gulf of Suez (animals), South Red Sea (animals) and the Gulf of Oman (animals). *Sepia omani* from the Gulf of Oman and from Hong Kong (animals); *Sepia rex*

only from Australia. In these three species the dorsal protective membrane of the tentacular club shows the perforations on the levels of the large suckers. This character had hitherto only been described by Berry for his *Sepia chirotrema* (see p. 123) and had not been mentioned by Adam & Rees (1966) for *Sepia prashadi* and *Sepia omani*.

Finally I have to mention a small error in the key to species which Cotton & Godfrey (1940: 438) give for *Decorisepia*: for *cottesloensis* they state 'Gladius nearly three times as long as wide', and for *jaenschi* 'Gladius less than two and a half times as long as wide', whereas the contrary is the case, as their figures 426 and 427 prove.

### *SEPIA ROZELLA* (IREDALE, 1926)

(Plate 6, Fig. 3)

*Solitosepia rozella* Iredale, T., 1926: 190, pl. XXI, fig. 6-7; 1954: 67

Iredale, T. & McMichael, D.F., 1962: 98

*Solitosepia rozella peregrina* Iredale, T., 1926a: 238; 1954: 67

#### Type localities

Manly Beach, N.S.W. (*S. rozella*); North-west Islet, Capricorn Group, Queensland (*S. rozella peregrina*).

#### Geographical distribution

Queensland and New South Wales; here tentatively identified from Shark Bay, Western Australia.

### MATERIAL

#### Dry specimens

- 1 Flinders Beach near Amity, Stradbroke I., Qld; June 1973; (a) WAM 781-75: 1 juv. spec.; (b) WAM 809-75: 1 spec. (Plate 6, Fig. 3).
- 2 ? South Passage, Shark Bay, W.A.; March 1966; WAM 786-75: 1 fragment.

#### Description

The shell is oval-elongate, broadest in the middle, rounded acuminate at both ends, rather thick in front of the middle. Dorsal surface with three faint longitudinal ribs, the median one more distinct; marginal areas broad,



TABLE 12  
Measurements of *Sepia rozella*

12a: Shell (in % of shell-length)

Loc.	L. in mm	W.	Th.	Str.z.	Spine
1b	106	34	10.4	64	6.6
1a	56	28.5+	9.0	68	6.2

12b: Literature records

Loc.	L. in mm	W. (%)	Author
<i>Sepia rozella rozella</i>			
Manly Beach	135	35	Holotype (Iredale, 1926: 190)
Manly Beach	150	32	(Iredale, 1954: 67)
Manly Beach	145	31	(Iredale, 1954: 67)
Manly Beach	130	34	(Iredale, 1954: 67)
Manly Beach	115	33	(Iredale, 1954: 67)
Manly Beach	80	36	(Iredale, 1954: 67)
Manly Beach	58	36	(Iredale, 1954: 67)
Manly Beach	50	40	(Iredale, 1954: 67)
Manly Beach	42	40.5	(Iredale, 1954: 67)
Manly Beach	34	44	(Iredale, 1954: 67)
<i>Sepia rozella peregrina</i>			
North-West Islet	89	38	Holotype (Iredale, 1926a: 238)

chitinous with a thin calcareous covering. Nearly the whole dorsal surface is granulous; in the anterior portion of the shell the granules are disposed more or less along the growthlines, but on the posterior part and especially on the marginal areas they form an irregular reticulate pattern. The posterior end in front of the spine is smooth and shiny. The ventral surface shows a deep median sulcus in the striated zone and a narrow shallow median depression on the last loculus. The deep sulcus is flanked by two strongly convex, rounded ribs, which diminish gradually towards the posterior end. At the posterior end the striae are slightly convex and become more and more reversed V-shaped in the sulcus. At each side the striated area is limited by a narrow marginal smooth zone. In the posterior half, the limbs of the rose-coloured inner cone are rather broad, reflected and fused with the outer cone; their outer margin is flat and shiny, broadest at the posterior end, which surrounds a rather deep depression. The outer cone is continuous

between the inner cone and the spine. The latter is strong, directed upwards, with a distinct, straight, ventral keel and a ventral notch at its base, whereas the dorsal side is convex in the basal half. In the juvenile specimen, this dorsal side of the spine is straight and the ventral keel slightly convex.

## Remarks

The largest specimen corresponds with the original description, but the median dorsal rib is much narrower than in the original figure (pl. XXI, fig. 7). As in Iredale's species the descriptions and figures often show differences; I believe that the above-described specimens belong to *Sepia rozella* (Iredale, 1926).

As to '*Solitosepia rozella peregrina* Iredale, 1926', the author states: 'shell smaller, shorter and comparatively broader, the inner cone wider, the rose colour restricted to a narrow band; the dorsal sculpture more pronounced than in the typical form'. As this subspecies has not been figured, it is difficult to appreciate its value, but the differences mentioned do not seem to justify a subspecific separation. More material is needed to decide about its status.

## Addendum

Up to the present the animal of this species had not been described. But after this text was finished, the Royal Institute of Natural Sciences (Brussels) received two female specimens, collected at La Perouse, New South Wales, in 1972, by Mr Van Hauwe. Unfortunately these two specimens, with a dorsal mantle-length of 108 and 120 mm, are in rather poor condition and do not allow a detailed description, except of the tentacular club. The latter measures 13% in both specimens, which is rather short. The well-developed swimming-membrane extends beyond the base of the club. The protective membranes are wide, united at the base of the club. The suckers are arranged in oblique, transverse series of eight; those of the third longitudinal row, counted from the dorsal side, are widest, in the smaller specimen as wide as the armsuckers (0.9%), in the other one slightly wider (1.0%).

The shells show the following measurements (in % of shell-length):

L. in mm	W.	Th.	Str.z.	Spine
120	33.5	10	71	4.2
108	36	11.5	62	4.6



They correspond with the above-described shells, but the median dorsal rib is as wide as in the original figure. The inner cone is dark rose-coloured. In the smaller specimen the ventral sulcus is much deeper and narrower than in the other specimen.

*SEPIA BRAGGI* VERCO, 1907

(Plate 10, Figs 1-4)

*Sepia braggi* Verco, J.C., 1907: 213, pl. XXVII, fig. 6

? Hedley, Ch., 1908: 134; 1918: M33

? Gatliff, J.H. & Gabriel, C.J., 1909: 37

? May, W.L., 1910: 307

Chapman, F., 1912: 23, pl. I

Jackson, J.W., 1931: 149

Adam, W. & Rees, W.J., 1966: 79, pl. 19, fig. 121-126

*Arctosepia braggi* Verco, J.C. & Cotton, B.C., 1928: 127

? Cotton, B.C., 1929: 90; 1931: 41, fig. 9

? MacPherson, J.H. & Chapple, E.H., 1951: 156

Iredale, T., 1954: 74 (? pars)

? Iredale, T. & McMichael, D.F., 1962: 99

? MacPherson, J.H. & Gabriel, C.J., 1962: 409, fig. 479

? *Arctosepia braggi xera* Iredale, T., 1954: 74

*Sepia (Arctosepia) braggi* Cotton, B.C. & Godfrey, F.K., 1940: 440 (pars), fig. 428

? *Sepia elongata* Tate, R. & May, W.L., 1901: 351 (*non* d'Orbigny, 1845)

? *Sepia* sp. Meyer, W. Th., 1909: 335, fig. 11

Type localities

Glenelg, South Australia (*S. braggi*); northwestern Tasmania (*S. braggi xera*).

Geographical distribution

Uncertain because of doubtful identifications in the literature; probably South Australia (type loc.) to at least as far north as Cockburn Sound, Western Australia. One badly preserved specimen from off Broome (loc. 2) is tentatively identified as this species which would extend the species range far into the tropical waters of northern Western Australia.

## MATERIAL

### Spirit specimens

- 1 NE of Rottnest I., W.A., 34 m; September 1965; WAM 437-65: 1 ♀ (Plate 10, Fig. 3).
- 2 NW of Broome, W.A. (17°31.5'S, 121°27'E), 81 m; December 1969; WAM 854-75: 1 ♀ (in bad condition, M.L.d. 36 mm).
- 3 N of Rottnest I., W.A. (from 31°56.8'S, 115°29.4'E to 31°51.8'S, 115°35.3'E), 38 m; February 1972; WAM 855-75: 1 ♂ (Plate 10, Fig. 4).
- 4 Cockburn Sound, W.A.; July 1972; WAM 491-76: 1 ♂, 1 ♀.
- 5 Off Rockingham and Kwinana, Cockburn Sound, W.A.; February 1970; WAM 871-75: 2 ♂, 4 ♀ (Plate 10, Fig. 1).

### Dry specimens

- 6 S of Naval Base Groyne, Cockburn Sound, W.A.; November 1965; WAM 501-65: 1 spec. (damaged).

TABLE 13

Measurements of *Sepia braggi*

13a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
3	♂	46.5	80	40	26	22.5	31	90	11	26	32	43	30	97	9.7	1.1	0.9
4	♂	43	84	41	26	21	35	91	9.5	35	46	63	40	116	9.3	0.9	0.9
5	♂	39	85	36	26	28	29	85	7.7	26	38	51	38	102	10.8	1.3	0.8
5	♂	37	89	41	27	27	34	96	8.1	35	46	67	41	—	—	1.1	—
1	♀	58	85	34.5	27.5	17	33	91	10.5	22.5	27.5	26	22.5	86	8.5	1.0	0.7
5	♀	56	87	36	25	22.5	31	89	8.9	27	32	27	30	89	6.2	1.1	0.7
5	♀	56	84	39	27	21.5	30	86	8.9	—	—	32	30	—	—	1.1	—
5	♀	55	87	41	25	25	30	87	9.1	31	40	36	36	—	—	1.1	—
5	♀	52.5	89	36	25	22	29	86	5.7	25	34	29	30	—	—	1.1	—
4	♀	48	83	42	25	23	30	83	8.3	25	33	31 <sup>+</sup>	31 <sup>+</sup>	—	—	1.0	—

13b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
3	♂	46	15.7	6.7	63	2.6
4	♂	43	16.3	6.1	—	—
5	♂	39	16.7	6.9	67	—
5	♂	37	16.2	6.2	73	—
1	♀	58	16.9	7.1	—	—
5	♀	56	16.1	6.4	77	—

## 13c: Literature records

Loc.	L. in mm	W.	Th.	Str.z.	Spine	Author or Coll.
Glenelg, S.A.	60	18.3	7.9	—	4.6	Holotype (Verco)
Adelaide, S.A.	54	16.3	6.9	71	3.7	I.R.Sc.N.B.
Torquay, Vic.	61.4	20	8.1	67	2.4	Adam & Rees, 1966
Torquay, Vic.	56.3	21	8.3	62	2.5	Adam & Rees, 1966
Adelaide, S.A.	56.0	20	8.0	66	3.6	Adam & Rees, 1966
Adelaide, S.A.	38.4	19.5	8.3	76	3.9	Adam & Rees, 1966
Adelaide, S.A.	29.0	21.5	9.0	54	3.4	Adam & Rees, 1966
Semaphore, S.A.	35.5	18.0	7.3	67	4.2	Adam & Rees, 1966
Semaphore, S.A.	32.5	21.5	9.2	63	—	Adam & Rees, 1966

## Description

The animal of this species has not been described previously. The mantle is broadly elongate, its dorsal margin broadly acuminate, reaching about halfway the eyes, the ventral margin deeply emarginate around the siphon; the posterior end is bluntly pointed. The fins are rather broad, their anterior ends not reaching the mantle-margin, their posterior ends extending slightly beyond the posterior end of the mantle and dorsally united before the end of the mantle. The head is short and broad, the eyes protruding. The arms of the female are rather short, the dorso-lateral ones slightly longer than the ventro-lateral ones. In the male, the ventro-lateral arms are much longer than the other ones and than those of the female. All the arms of the female are slightly keeled at their outer sides, the ventral ones with a more developed swimming-membrane which descends on the ventral side of the head up to the level of the eye-opening. In the male, the dorsal arms are slightly keeled near their distal tips, but rounded on the greater part of the outer sides. The lateral arms are rounded at their outer sides, without any keels, but the ventral ones do not differ from those of the female. In both sexes, the suckers are quadriserial on the ventral arms; on the other arms they are quadriserial on the basal portions, but biserial on the effilated tips, especially on the dorso-lateral arms of the female and on the ventro-lateral arms of the male, where they are very small and spaced. Except on the ventral arms, the protective membranes are rather narrow.

The left ventral arm of the male does not show any trace of a hectocotylyzation.

The tentacles are very long and slender, the clubs short. The swimming-membrane of the tentacular club is well-developed and extends beyond the base of the club. The dorsal protective membrane is wide, devoid of suckers;

at the base of the club the two protective membranes remain widely separated. The suckers seem to be arranged in 5 longitudinal series, 5 or 6 of the middle series being about twice as wide as the other ones. Their chitinous rings, as well as those of the armsuckers, are finely dentate.

The shell is very elongate, broadest in the anterior third, acutely rounded at the anterior end and acuminate posteriorly. The dorsal surface has a distinct, but low and narrow, median rib, vanishing towards the posterior end, which is neatly curved towards the ventral side. The non-calcified marginal portions are very wide: near the anterior end they are even broader than the median rib and extend up to the margins of the rib, only the latter being calcified; towards the middle of the length, the calcified portion extends laterally beyond the rib, but the chitinous margins remain very wide, diminishing towards the posterior end of the shell. The calcareous covering is weakly granulous, with irregular longitudinal lines, not only in the anterior part, but in well-preserved shells also in the posterior part, which is rose-coloured. The spine is slightly constricted at its base, devoid of keels, turned upwards, sometimes slightly curved with its ventral side concave. The ventral surface of the shell shows a distinct, narrow, median groove along its whole length, widening in the anterior part of the last loculus. At each side, the median groove is flanked by a slightly convex rib, which, in the anterior part of the striated area, has an abruptly sloping, flat or concave lateral part, separated from the outer cone by a smoother, narrow, marginal zone, separated from the striated area by the narrow limb of the inner cone. The limbs of the inner cone descend sometimes in the middle of the smooth marginal zones. In the extreme posterior part of the striated area, the transverse striae are slightly convex, but on the greater part of its length, the striae are distinctly convex at each side of the median groove and are incurved, V-shaped, in the groove. The limbs of the inner cone are very narrow, rounded ridges, the posterior part forming a slightly sharper ledge, which surrounds the shallow posterior excavation. The narrow outer cone forms two short posterior wings which surround the posterior part of the inner cone, constituting a cup-like formation, ornamented by tiny, radiating, calcareous keels.

#### Remarks

According to Jackson (1931: 149) 'Professor W.L. Bragg has presented his collection of South Australian marine mollusca to the Manchester Museum, and contained in this collection is the type-specimen of *Sepia braggi*.' Mr Charles Pettitt has kindly informed me that he could find no trace of the type of *Sepia braggi* in the type collection and in the general



collection of the Manchester Museum. The small collection of South Australian shells presented to the Museum by Prof. Bragg contains six cuttlebones, without any indications of the name or the locality. Of these six shells, which I had the opportunity to examine, four belong to *Sepia apama* Gray, 1849; the two others, one of which is only a small fragment, represent the above-described species. The nearly complete specimen (Plate 10, Fig. 2) has a length of nearly 50 mm (the extreme anterior part is lacking) and cannot be the type which, according to the original description, measured 60 mm.

Up to the present, only two small species of *Sepia* with an elongate shell have been mentioned from Western Australia under the names of *Sepia braggi* and *Sepia rhoda* (see p. 192). As the present collection of the Western Australian Museum contains three different species, two of which seem to be new species (see p. 190 and p. 193), with elongate shells, which are not easy to distinguish at first sight, it is necessary to ascertain if one of the three, and which one, represents *Sepia braggi*. As the type of this species seems to be lost, I consider the above-mentioned specimen as representing *Sepia braggi*; it agrees with the original description and figure and with the specimens described by Adam & Rees (1966: 79, pl. 19, fig. 121-126). Many of the other references of *Sepia braggi* have now become doubtful, especially those of Western Australia. It is noteworthy that only one, very badly preserved, beach collected dry shell in the present collection belongs to *Sepia braggi*; nearly all the other specimens belong to *Sepia cottoni* sp. nov. (p. 193), whereas the third species, *Sepia vercoi* sp. nov., is represented by a single animal and two dry shells (p. 190).

Adam & Rees (1966: 80-81) have discussed the different Australian species described by Iredale (1926; 1954) the animals of which are unknown, although Garrard (1961: 36) mentions the capture of 13 live specimens of '*Arctosepia versuta*' off the coast of New South Wales. As long as the animals of all these species are unknown, it is useless to discuss their status and their relationships.

The shell of *Sepia braggi* can easily be distinguished from that of the two other Western Australian species by its deeper median ventral sulcus and by the outline of the striae of the striated area, which are convex at each side of the sulcus, the dorsal surface differs by the very broad non calcified chitinous margins.

The shell figured on Plate 10, Fig. 3 (loc. 1) shows a curious malformation: at the right side (in the figure) of the ventral sulcus there is a very narrow, rounded rib, which does not reach the anterior end of the striated

area. In his description of *Sepia treba*, Iredale (1954: 75) mentions that 'the median furrow in one specimen' is 'elevated into a rib', whereas in the other specimen it is normal. And *Sepia rhoda* (Iredale, 1954: 75) shows 'instead of a linear groove, a raised rib along the striated area, but the linear groove appears in the last loculus'.

### *SEPIA VERCOI* SP. NOV.

(Plate 10, Figs 5 and 6)

#### Holotype

- 1 CSIRO Stn 200, W of Shark Bay, W.A. (25°31'S, 112°29'E), 130 m; leg. HMAS *Diamantina*; 0220 hrs, 9 October 1963; WAM 441-65: 1 ♂ in spirit (Plate 10, Fig. 5).

#### Paratypes

- 2 North shore of Broke Inlet, W.A. on beach; leg. J.K. Porter; 29 August 1974; WAM 770-75: 1 dry shell (incomplete).
- 3 CSIRO Stn 192, NW of Carnarvon, W.A. (24°04'S, 112°59'E), 138 m; leg. HMAS *Diamantina*; 0400 hrs, 8 October 1963; WAM 772-75: 1 dry shell (Plate 10, Fig. 6).

#### Geographical distribution

Southwestern Australia from Broke Inlet on the south coast to Carnarvon.

TABLE 14

Measurements of *Sepia vercoi*

#### 14a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
1	♂	31	82	49	26	19	37	85	9.5	39	26	26	32	130	11	1.6	0.6

#### 14b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
1	♂	31	23	9	65	—
3	—	50.5	21	8.9	—	6



## Description

The single animal in the present collection is a mature male, its penis filled with spermatophores. But as in other Sepiidae the animals may continue their growth after having attained maturity, we do not know if this specimen is full-grown.

The mantle is elongate-oval, its dorsal margin acutely acuminate, surpassing the mid-level of the eyes; the ventral margin is slightly emarginate. The posterior end is bluntly acuminate. The fins are rather narrow but contracted, they do not reach the anterior and posterior ends of the mantle. The rather short arms are united at the base by a low subequal web, which is lacking between the ventral arms. The dorsal arms are slender, effiliated, very slightly keeled at their outer sides, with the suckers biserial along their whole length. The lateral arms are much shorter, stouter, each with a low swimming-membrane and quadriserial suckers. The ventral arms are longer than the lateral ones, but shorter than the dorsal ones; each with a well-developed swimming-membrane, which does not reach beyond the base of the arm. The suckers are quadriserial, those of the right ventral arm diminishing gradually in size from the base to the tip of the arm. The left ventral arm possesses about 6 transverse rows of 4 big suckers on the basal half of the arm; on the distal half they are abruptly much smaller and widely spaced, but closer together near the tip of the arm. On all the arms the protective membranes are well-developed. The arm-suckers are globular with a narrow opening. On the lateral and ventral arms the median suckers are wider than the marginal ones. The chitinous rings are smooth. The tentacles are long and slender. The tentacular club is short and narrow, its swimming-membrane wide and thin, extending slightly beyond the base of the club. The protective membranes remain separated at the base of the club, the dorsal one being wide. The tentacular suckers seem to be arranged in 5 longitudinal series, 5 or 6 suckers of the median series being about twice as wide as the neighbouring ones; their chitinous rings are finely dentate. The largest tentacular suckers are less than half as wide as the biggest arm-suckers. The chromatophores are minute, more crowded on the median part of the dorsal surface of the mantle and above the eyes. Moreover the dorsal sides of the arms each show some larger orange spots, situated on a deeper level, under the small chromatophores.

Unfortunately the shell of the holotype is in rather bad condition and could not be extracted intact; the description is completed with that of the best preserved paratype (3). The shell is elongate, widest in the anterior third and tapering gradually towards the posterior end, which is gently

curved downwards. The dorsal surface is flattened, slightly convex, except near the posterior end, which is more rounded. A very low median rib is weakly indicated. The chitinous, non-calcified margins are very narrow in the posterior half, slightly wider in the anterior third where they each attain about one-sixth of the width of the shell. The greater part of the dorsal surface is calcified, with a reticulate granulous pattern, which forms irregular longitudinal lines on the median rib and near the margins. On the posterior half the calcareous part is separated at each side from the chitinous margin by a stronger calcareous keel. The extreme posterior end is covered by a smooth glaze-like substance, covering also the base of the spine, which is straight, devoid of keels and slightly directed upwards. The ventral surface shows a very shallow, narrow, median sulcus along its whole length. The striae of the striated area are weakly convex, especially in the middle where they are nearly straight. The limbs of the inner cone are very narrow, rounded, shiny ridges, limiting the striated area and vanishing towards the middle of the length of the shell. The posterior part of the inner cone forms a slightly wider ledge, surrounding the weak posterior depression. At each side, a narrow smooth area separates the inner cone from the outer cone. The latter forms a cup-like widening, separating the inner cone from the spine.

#### Remarks and relationship

As the animals of the Australian species, possessing an elongate shell, have never been described, the animal of *Sepia vercoi*, of which only the male is known, can only be compared with that of *Sepia braggi*, described above (p. 187). The dorsal arms of *Sepia vercoi* possess biserial suckers, whereas in *Sepia braggi* the suckers are quadriserial on the basal part of these arms. The latter species has much longer lateral arms with effiliated tips with biserial suckers and the left ventral arm shows no hectocotylization. Moreover the globular suckers of *Sepia vercoi* are relatively much bigger. *Sepia kiensis* Hoyle, 1885, from the Arafura Sea has quadriserial suckers on all its arms, whereas *Sepia sulcata* Hoyle, 1885, from the Arafura Sea has biserial suckers on the dorsal and dorso-lateral arms but a quite different hectocotylus and a much broader shell.

The shell of *Sepia vercoi* differs from that of *Sepia braggi* by the much shallower ventral median sulcus, by the different outline of the striae of the striated area, and by the much narrower chitinous margins of the dorsal surface.

'*Arctosepia rhoda* Iredale, 1954' (p. 75, pl. IV, fig. 10-12), which is based on a single shell from Point Cloates, mid-western Australia, has a

thicker shell (the thickness measuring 11.6% of the length, which was 52 mm) which shows 'instead of a linear groove, a raised rib along the striated area, but the linear groove appears in the last loculus'.

This new species has been dedicated to the late J.C. Verco, author of *Sepia braggi*.

*SEPIA COTTONI* SP. NOV.

(Plate 11, Figs 1-6)

**Holotype**

- 1 CSIRO Stn 46, W of Lancelin, W.A. ( $31^{\circ}54'S$ ,  $114^{\circ}55'E$ ), 114-122 m; leg. HMAS *Diamantina*; 1755 hrs, 5 February 1964; WAM 435-65: 1 ♂ in spirit (Plate 11, Fig. 1).

**Paratypes — spirit specimens**

- 2 CSIRO Stn 34, W of Dirk Hartog I., W.A. ( $25^{\circ}54'S$ ,  $112^{\circ}38'E$ ); leg. HMAS *Diamantina*; 1600 hrs, 3 February 1964; WAM 483-76: 1 juv. spec.
- 3 CSIRO Stn 187, SW of Point Cloates, W.A. ( $23^{\circ}39'S$ ,  $113^{\circ}11'E$ ), 134 m; leg. HMAS *Diamantina*; 1527 hrs, 7 October 1963; WAM 494-76: 5 ♀ (Plate 11, Fig. 4).
- 4 Armstrong Point, Rottnest I., W.A., deep rock pool open to sea at low tide; 25 March 1958; WAM 484-76: 1 ♀.
- 5 CSIRO Stn 208, NW of Bluff Point, W.A. ( $27^{\circ}40'S$ ,  $113^{\circ}20'E$ ), 130 m; leg. HMAS *Diamantina*; 0400 hrs, 10 October 1963; WAM 424-65: 1 ♂, 2 ♀ (Plate 11, Fig. 3).
- 6 WNW of Rottnest I., W.A., 146-164 m; leg. R.W. George on FV *Bluefin*; 14 August 1962; WAM 430-65: 1 ♂.
- 7 CSIRO Stn 40, SW of Bluff Point, W.A. ( $28^{\circ}14'S$ ,  $113^{\circ}28'E$ ), 110 m; leg. HMAS *Diamantina*; 1520 hrs, 4 February 1964; WAM 432-65: 1 ♀.
- 8 Stn UMRT 6908-9, NW of Broome, W.A. ( $17^{\circ}31.5'S$ ,  $121^{\circ}27'E$ ), 83 m; leg. *Umitaki Maru*; 21 December 1969; WAM 490-76: 1 juv. spec. (M.L.d. 31 mm, shell 31 x 7 mm).

**Paratypes — dry specimens**

- 9 Cottesloe Beach, Perth, W.A.; leg. L. Glauert; February 1928; WAM 13384: 2 spec. + 2 broken spec.

- 10 Cottesloe Beach, Perth, W.A.; leg. L. Glauert; July 1928; WAM 1292-76: 13 spec. + 4 spec. (damaged).
- 11 Cottesloe Beach, Perth, W.A.; leg. L. Glauert; July 1928; WAM 13595: 1 spec (Plate 11, Fig. 2).
- 12 Cottesloe Beach, Perth, W.A.; leg. L. Glauert; July 1928; WAM 13596/13607: 13 spec. (Plate 11, Figs 5 and 6).
- 13 Calgardup Beach near Margaret River, W.A.; leg. Miss Glauert; October 1938; WAM 1293-76: 15 spec.
- 14 S of Naval Base Groyne, Cockburn Sound, W.A.; leg. S.M. Slack-Smith; 9 November 1965; WAM 502-65: 1 spec.
- 15 Sorrento Beach, Perth, W.A.; leg. S.M. Slack-Smith; 7 November 1965; WAM 508-65: 1 spec. + 3 spec. (broken).
- 16 Ocean Beach, near Augusta, W.A.; leg. B.R. Wilson and S.M. Slack-Smith; 19 March 1975; WAM 768-75: 3 spec. (damaged).
- 17 Flinders Beach near Amity, Stradbroke I., Qld; leg. B.R. Wilson and S.M. Slack-Smith; 16 June 1973; WAM 769-75: 1 spec.
- 18 Cheynes Beach (Hassall Beach), W of Cape Riche, W.A.; leg. S.M. Slack-Smith *et al.*; 3-4 December 1968; WAM 771-75: 1 spec. (incomplete).
- 19 West end, Rottnest I., W.A.; leg. S.M. Slack-Smith; 30 June 1974; WAM 782-75: 2 spec.

### Geographical distribution

Western Australia from Hassell Beach on the south coast to Broome. Also recorded from Stradbroke I., Queensland (a single shell specimen) implying a northern Australian distribution.

TABLE 15

Measurements of *Sepia cottoni*

15a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.L.	T.cl.	S.a.	S.t.
5	♂	45.5	80	40	22	13	24	81	—	44	33	31	31	110	11	1.5	0.9
1	♂	43.5	84	32	24	31	26	92	11.5	50	46	50	57	—	—	1.4	—
3	♀	55	69	36	24	—	—	76	7.5	29	24	25	27	—	—	1.3	—
5	♀	42	81	37	23	28	24	79	7	29	29	29	29	120	14	1.7	1.2
5	♀	41	78	35	23	22	27	71	7.5	24	29	29	24	160	12	1.7	1.7
3	♀	41	79	41	22	24	24	83	12	24	27	27	27	120	10	1.7	1.0
4	♀	22.5	84	42	29	27	33	84	6.5	29	22	24	29	—	—	1.3	—

15b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine	Loc.	Sex	L. in mm	W.	Th.	Str.z.	Spine
11	—	64.6	16.2	7.1	70	4.9	10	—	34.1	23.5	9.3	63	5.0
14	—	57.3	18.2	7.5	68	5.2	10	—	33.5	23.3	8.9	61	5.4
10	—	51	17.3	8.4	61	—	6	♂	33	22.5	10.3	63	5.8
15	—	48.3	19.3	7.9	72	5.4	13	—	32.9	23.7	9.4	58	6.7
13	—	47.1	18.3	7.6	70	5.3	10	—	32.8	24.4	10.4	61	6.1
12	—	47.1	19.8	7.4	70	5.5	12	—	31.5	23.8	9.5	67	6.3
12	—	46	19.6	8.0	70	4.8	9	—	31.2	22.1	9.0	64	4.8
19	—	44	21.6	9.1	66	3.4	13	—	31.1	21.9	9.3	58	6.4
17	—	43.8	20.6	8.7	64	4.6	13	—	31.1	22.5	8.7	61	6.4
12	—	43.7	20.4	9.1	64	4.6	8	juv.	31	22.6	—	—	—
1	♂	43.5	19.0	7.4	72	5.7	12	—	27.3	25.6	9.9	59	8.0
5	♀	43	21.5	9.5	63	5.7	10	—	27	27.0	10.8	63	5.5
12	—	42.3	20.3	8.0	68	5.4	13	—	25.9	24.4	9.6	58	3.9
12	—	41.7	20.8	7.9	69	5.3	12	—	24.5	28.6	9.8	57	7.3
3	♀	41	23.0	9.0	59	4.9	10	—	23.7	27.0	10.6	59	7.2
9	—	37.5	20.8	9.9	59	5.3	10	—	23.7	27.5	9.7	59	7.2
13	—	36.3	19.8	8.8	58	5.5	10	—	22.8	27.2	8.8	61	—
10	—	36	23.3	8.3	72	4.2	4	♀	22.5	24.0	9.8	53	4.9
10	—	35.9	23.5	9.5	67	4.7	12	—	21.5	25.6	9.3	56	5.6
10	—	34.8	23.6	10.1	59	5.7	19	—	21.5	25.6	9.3	60	4.6
13	—	34.7	21.0	9.2	55	4.3	12	—	21	27.6	9.5	62	4.3
12	—	34.6	22.2	9.2	66	6.6	10	—	20.8	27.4	10.1	58	6.2
12	—	34.5	24.6	8.7	61	7.2	13	—	20.5	28.3	9.7	62	—
10	—	34.3	24.8	9.3	64	5.8	13	—	19.4	26.8	9.8	59	—
12	—	34.3	21.9	8.1	64	5.8							



## Description

The mantle is elongate, more than twice as long as wide, the posterior end acuminate. The dorsal mantle-margin projects strongly forward, the ventral margin is largely emarginate. The fins start behind the lateral mantle-margin and surpass the posterior end of the mantle without being united in front of the spine. The arms show a marked sexual difference. In the female they are subequal, short, rather stout, the dorsal and dorso-lateral ones having an outer membraneous keel, the ventro-lateral and ventral ones possessing a much more developed swimming-membrane. The globular suckers have a small opening and a finely dentate chitinous ring; they are quadriserial on the greater part of the length of each arm, but biserial at the base and at the extreme distal end. The protective membranes are well developed. The arms of the males are quite different. Unfortunately only the holotype is in good condition. First of all, the left ventral arm does not show any trace of a hectocotylization. In the holotype the arms are about twice as long as those of the females. The basal third of these arms bears a few biserial suckers, followed by about 7-8 transverse rows of four globular, rather big suckers, the median ones being larger than the marginal ones. The distal two-thirds become gradually narrower and the last third is threadlike in all the arms, except the ventro-lateral ones. After the basal normal portion of the arms, the suckers diminish rapidly in size, become biserial and disappear on the threadlike tip. The protective membranes are wide on the basal half of each arm, but disappear on the transformed distal half, except on the two ventro-lateral arms, where they show a very curious transformation. On these arms, after the 7th transverse row of 4 suckers, these membranes, especially the dorsal ones, become thicker and wider with very thick transverse ridges, which alternate, each ridge uniting the inner margin of one membrane to the outer margin of the opposite membrane. Each ridge bears two small suckers, an inner one at the base of one protective membrane and its smaller partner near the outer margin of the opposite membrane. On the ventral membrane these outer suckers are situated almost on the margin, but on the much wider dorsal margin they are situated about halfway on the thick ridges. As on the effiliated arms, the suckers diminish rapidly in size, then the inner ones, which alternate on each side with the opposite ridges, disappear, but the smaller minute outer suckers remain for a long distance and disappear finally near the tip of the arm, where the protective membranes persist. On the effiliated other arms, the arrangement of the suckers in alternating pairs, situated on transverse ridges, is principally the same but much less pronounced, and on these arms the protective membranes are not enlarged and disappear. This curious



transformation of the ventro-lateral arms recalls that of the dorsal arms of *Sepia incerta* Smith, 1916, where the ventral protective membrane is wider than the dorsal one (see Adam & Rees, 1966: 68, and Roeleveld, 1972: 213). The latter species also lacks the hectocotylization of the left ventral arm.

The web is shallow between the dorsal, dorso-lateral, ventro-lateral and ventral arms, and absent between the latter ones. The ventral portion of the buccal membrane of the female is ventrally extended and possesses two spermathecae. The tentacles are very long and slender, with relatively small clubs. The swimming-membrane is well-developed and extends slightly beyond the base of the club. The protective membranes are separated at the base of the club, the dorsal one rather broad and devoid of suckers. The tentacular suckers seem to be arranged in 5 longitudinal suckers, about 6 suckers of the middle series being nearly twice as wide as the other ones. In one of the female specimens of locality 5, these big suckers are of the same width as the largest arm-suckers, but in the other specimens they are much smaller; otherwise this specimen does not differ from the other ones. The chitinous rings of the tentacular suckers are finely dentate with distinctly spaced denticles, which are longest at the distal side of the ring.

The shell is very elongate, broadest in the anterior third, acutely rounded at the anterior end and acuminate posteriorly. The shell of the female (Plate 11, Figs 3-4) seems to be slightly wider than that of the male and its lateral margins are very weakly angular between the first and second third of the length, whereas in the male (Plate 11, Fig. 1) these margins are very slightly convex. Unfortunately not enough animals were available to study this character. The dorsal surface has a distinct, but low and narrow, median rib, vanishing towards the posterior end. The surface is weakly granulous, with irregular longitudinal lines, not only in the anterior part but, in well-preserved shells, also in its posterior portion. The granulous calcareous layer covers the greater part of the dorsal surface, but in the anterior half the chitinous lateral margins are rather wide, as in the preceding species. The dorsal surface is more or less rose-coloured and neatly curved towards the ventral side. The spine is slightly constricted at its base, without keels, turned upwards, sometimes slightly curved with its ventral side concave. The ventral surface shows a shallow, narrow, median groove along its whole length. In the anterior part of the striated area, the surface is flattened in the middle, with abruptly sloping, flat or concave lateral parts, separated from the outer cone by smoother, narrow, marginal zones, separated from the striated area by the narrow limbs of the inner cone. These limbs descend sometimes in the middle of the smooth marginal zones. The striae of the striated area are weakly convex, especially in the middle where they are

nearly straight, with a slight incurvation in the median groove. The limbs of the inner cone are very narrow, rounded ridges; the posterior part forming a slightly longer, sharper ledge, which surrounds the posterior excavation. The length of this posterior ledge is rather variable and depends on the size of the shell. The narrow outer cone forms two short posterior wings, which surround the posterior part of the inner cone, constituting a cup-like formation, ornamented with tiny radiating calcareous keels.

### Remarks and relationship

As regards the animals, the female of *Sepia cottoni* can only be compared with that of *Sepia braggi*, as the female of *Sepia vercoi* is unknown. The general form and the relative measurements of the first two species do not show any noteworthy differences, except the arm-suckers of *Sepia cottoni* which are bigger. The males show more differences: *Sepia vercoi* possesses a hectocotylus, which is lacking in the two other species. On the other hand *Sepia cottoni* has all the arms much longer than both the other species, and the curious transformation of the ventro-lateral arms. The tentacular clubs are the same in the three species, but judging from the single animal of *Sepia vercoi*, the suckers of this species seem to be relatively smaller.

The shell of *Sepia cottoni* strongly resembles that of *Sepia vercoi* by the narrow, shallow median groove on the ventral surface, by the outline of the striae of the striated area, which are nearly straight in the middle, and by the relatively narrow chitinous margins of the dorsal surface. But the granulation of this surface is less coarse in *Sepia cottoni* and does not show the calcareous keel which, in the posterior part separates the calcareous portion from the chitinous margin.

As to the species described by Iredale, it is very difficult to compare them with the three above-described species, because the descriptions and the figures of the shells do not show enough details. *Sepia rhoda* (Iredale, 1954: 75, pl. IV, fig. 10-12) is much wider than *Sepia braggi*, but has about the same width as *Sepia vercoi* and *Sepia cottoni* of the same size. The thickness of the shell of *Sepia rhoda* is much more than that of the three other species, and the median groove of the ventral surface is lacking along the striated area, which shows a narrow median elevated rib.

Iredale (1926) described two new species from New South Wales: '*Arctosepia limata*' (p. 193, pl. XXIII, fig. 7-8) and '*Arctosepia versuta*' (p. 194, pl. XXIII, fig. 5-6). According to the description, the shell of the former species which measured 36 x 8 mm, is smaller than *Sepia braggi*, proportionately broader, less narrowed posteriorly, different shape, etc.

The shell of the second new species, which measured 33 x 7 mm, is smaller and slightly different. It is not impossible that these two species belong in fact to a single species, the shell of *Sepia versuta* representing a male specimen and that of *Sepia limata* a female. Both strongly resemble male and female shells of *Sepia cottoni* of the same size. It is noteworthy that according to Iredale (1954: 74) hundreds of shells of *Sepia limata* have been collected 'but the majority have been broken, as the bones are brittle, while none exceeding these measurements has been collected in the Sydney district, and specimens have been secured on the north coast of New South Wales, and south Queensland.' If *Sepia limata* was conspecific with *Sepia cottoni*, the shell of which may attain 64.6 mm, it would be very curious that Iredale only collected small specimens.

As to *Sepia versuta*, Iredale (1954: 75) states: 'In southern Australia large shells (for the group) occur with the name *braggi*, and it would appear that these small New South Wales shells are degenerate representatives of the larger ones. Thus, Whitley collected a series of *braggi*-like bones in northwestern Tasmania, and while most of these are obviously of the true *braggi* style, some others are of the *versuta* form, and appear to be far larger relatives.' 'The northern *versuta* was separated from *limata* as being "smaller, the growth lines more closely packed, the posterior end much less rapidly tapering, the anterior ventral more swollen, less excavate posteriorly, and with more numerous striae". The Tasmanian specimens measure 51 by 10 mm and 48 by 10 mm, and are elongate and narrow, the width never increasing rapidly, the ventral surface elevated, the median furrow in one specimen elevated into a rib, in the other normal, the striae rather coarse, the hood small, the spine short and thickened, the dorsal area smoothish, the median rib scarcely indicated. This may have been confused elsewhere with *braggi*, passing as the male or immature, but it is here named *Arctosepia treba* sp. nov., from Stanley, northwestern Tasmania.' This new species has not been figured.

In order not to increase the already existing confusion among this group of species, I prefer to consider *Sepia cottoni* as a separate species, characterized by the male which lacks a hectocotylus, but has both its ventro-lateral arms transformed, and by the shell with a weak median groove on its ventral surface, slightly convex or even straight striae in the middle of the striated area, a weakly granulous dorsal surface and rather wide chitinous margins in the anterior half of the shell. This new species has been dedicated to the late B.C. Cotton.

Judging by the numerous dry shells in the present collection, this species seems to be the most common of the elongate species on the Western

Australian coast. Several of the references given with a question mark under *Sepia braggi* (p. 185) probably apply to our new species.

### *SEPIA REESI* SP. NOV.

(Plate 4, Fig. 3)

#### Holotype

- 1 Salmon Bay, Rottnest I., W.A.; leg. L. Glauert; September 1931; WAM 497-76: 1 dry shell (Plate 4, Fig. 3)

#### Paratypes

- 2 Salmon Bay, Rottnest I., W.A.; leg. L. Glauert; September 1931; (a) WAM 498-76: 1 dry shell.
- 3 Salmon Bay, Rottnest I., W.A.; leg. L. Glauert; September 1931; (b) WAM 499-76: 1 dry shell.

#### Geographical distribution

Unknown beyond the type locality.

TABLE 16  
Measurements of *Sepia reesi*

Specimen	L. in mm	W.	Th.	Str.z.	Spine
Holotype 1	45.2	25	7.3	71	4.9
Paratype 2	45+	27.5	8.4	78	-
Paratype 3	42.4	28.5	8.3	73	3.1

#### Description

Shell elongate, sharply rounded anteriorly, broadly rounded posteriorly. Dorsal surface salmon-coloured, the holotype with a distinct median rib, limited by very narrow grooves, the paratypes with a less distinct rib, without limiting grooves. The dorsal surface is nearly smooth near the anterior end, weakly granulous on the remaining part, the granules forming a reticulate pattern near the posterior end and at each side, at the bases of the lateral parts of the outer cone, an irregular, keel-like longitudinal ridge, separated from the median part of the surface by an indistinct groove.

The ventral surface shows a narrow median groove (sulcus) along the whole striated zone and on the greater part of the last loculus. The striae



are nearly straight transverse in the posterior portion, more and more reversed V-shaped in the anterior part of the striated zone. The latter is flanked at each side by a rather broad, nearly smooth area, which is flat or weakly concave and which descends abruptly towards the outer cone. At each side this smooth zone, which shows in fact very weak growthlines, forms a rounded angle with the nearly flat median part of the striated zone. In the posterior half of the shell the limbs of the inner cone separate the striated area from the lateral smooth zones.

The inner cone has very narrow, rounded limbs and is bluntly rounded posteriorly, surrounding a shallow depression; the limbs disappear gradually towards the middle of the striated area. The outer cone is narrow, slightly enlarged in the posterior part as two wings, which are continuous between the spine and the inner cone. The spine is rounded and distinctly turned upwards, but not curved. The posterior end of the shell is regularly curved towards the ventral side.

#### Remarks and relationship

These three specimens, the holotype representing perhaps a male and the paratypes the female, resemble *Sepia mira* (Cotton, 1932: 546, fig. 7-9) from Queensland (North-West Islet, Capricorn Group), for which the author created a new genus, *Tenuisepia*, characterized by: 'Sepion small, elongate, narrow, five times as long as broad; inner cone much reduced; no ventral sulcus; dorsum without ribs; spine medium, stout, rounded'. But *Sepia mira*, of which only one specimen is known, has a narrower shell, more elongate posterior wings at the outer cone, no dorsal keel, no ventral sulcus, a less rounded posterior portion of the inner cone and of the outer cone, a spine which is not turned upwards, and the posterior end of the shell less curved towards the ventral side.

On the other hand, the shell of our new species resembles the female shell of *Sepia chirotrema*, which has been described as *Sepia hendryae* (see p. 125), but the latter is much broader and the limbs of the inner cone and the ventral sulcus are also much wider; the sculpture of the dorsal surface is about the same.

I dedicate this species to the late Dr W.J. Rees, a dear friend and colleague with whom I published the review of the Sepiidae in 1966.

#### *SEPIA (METASEPIA) PFEFFERI* HOYLE, 1885

(Plate 12, Fig. 6; Plate 13, Figs 2-3)

*Sepia (Metasepia) pfefferi* Hoyle, W.E., 1885: 199; 1885a: 304; 1886: 145, pl. XXI, figs 1-10

Brazier, J., 1892: 13

Adam, W. & Rees, W.J., 1966: 114, pl. 43, fig. 256

*Metasepia pfefferi* Iredale, T., 1954: 78

?*Metasepia pfefferi laxior* Iredale, T., 1926a: 240, pl. XXXV, figs 9-10; 1954: 78

?*Metasepia pfefferi wanda* Iredale, T., 1954: 78, pl. V, figs 9-11

### Type locality

Challenger Sta. 188, 9°59'S, 139°42'E, south of Papua, Arafura Sea, 28 fms [green mud], 19-IX-1874.

### Geographical distribution

Northern Australia; southwards to Mandurah in Western Australia and to the Capricorn Group, Queensland, on the east coast.

## MATERIAL

### Spirit specimens

- 1 Shark Bay, W.A.; September 1963; WAM 466-65: 1 ♀ (Plate 12, Fig. 6).
- 2 SW of Jurien Bay, W.A. (30°38'S, 114°47'E), 110 m; December 1970; WAM 856-75: 1 ♀ (Plate 13, Fig. 2).
- 3 W of Mandurah, W.A. (32°33'S, 115°04'E), 110 m; November 1970; WAM 859-75: 1 ♀ (Plate 13, Fig. 3).
- 4 Shark Bay, W.A.; early 1966; WAM 492-76: 1 ♀.
- 5 Shark Bay, W.A.; August 1962; WAM 431-65: 1 ♀ (M.L.d. 32 mm).

TABLE 17

Measurements of *Sepia* (*Metasepia*) *pfefferi*

17a: Animal (in % of dorsal mantle-length)

Loc.	Sex	M.L.d. in mm	M.L.v.	M.W.	M.Th.	H.L.	H.W.	F.L.	F.W.	A.L.I	A.L.II	A.L.III	A.L.IV	T.cl.	S.a.	S.t.
4	♀	57	84	68	56	42	58	100	14	32	46	49	47	17.5	3.2	—
1	♀	44	82	77	55	34	66	100	18	48	50	57	50	22.5	2.7	3.2
3	♀	27	78	85	41	59	67	96	7.4	59	70	74	63	14	2.6	3.7
2	♀	16	87	93	62	56	94	100	12.5	56	69	81	69	22	3.7	5.6
Type	♀	52	94	—	—	48	63	96	11.5	38	52	58	58	11.5	2.3	3.3



17b: Shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.
4	♀	42	55	—	—
1	♀	35	53	15	63
3	♀	22.5	58	18	53
2	♀	14	64	14	46
Type	♀	42	55	16	71

17c: Literature records

Subspecies	L. in mm	W. (%)	Author
<i>laxior</i>	51	63	(Iredale, 1926a: 240)
<i>laxior</i>	36	67	(Iredale, 1926a: 240)
<i>laxior</i>	27	59	(Iredale, 1926a: 240)
<i>wanda</i>	43	63	(Iredale, 1954: 78)
<i>wanda</i>	38	61	(Iredale, 1954: 78)
<i>wanda</i>	20	62	(Iredale, 1954: 78)

## Description

The mantle is broadly oval and very thick; its dorsal margin slightly angular, the ventral margin broadly emarginate around the funnel. In the larger specimens the dorsal surface is dark purple with irregular lighter coloured patches, especially on the base of the fins, the latter having a wide uncoloured border. The two small specimens are light reddish brown. The flat ventral surface of the mantle is greyish, bordered by a dark V-shaped ridge, separating it from the sides of the mantle which are darker coloured with, at the base of each fin, a series of big roundish lighter patches. In the two small specimens, the V-shaped ridge is very dark in contrast with the ventral and lateral sides; the same dark-purplish colour is seen on the arms as irregular patches along the swimming-membrane and on the distal portion of the arms.

The fins start at a short distance behind the mantle-margin and are distinctly separated at the blunt posterior end of the mantle; they are wide and on both ventral and dorsal surfaces pigmented only on the inner half of their width.

The head is short, the eyes are not very prominent.

The arms are short and very stout in their basal half, acuminate in their distal half. The dorsal arms and in a lesser degree, the dorso-lateral and

ventro-lateral ones have filiform tips with only a few minute suckers. The basal half of each arm bears rather large suckers, disposed in transverse rows of four, the median ones somewhat wider than the marginal ones. On the dorsal arms there are 6 transverse rows of big suckers, on the lateral arms 8-10 rows and on the ventral ones 7-8 rows. On the remaining portion of each arm the suckers are much smaller, becoming minute and biserial near the tip. The protective membranes are rather wide covering completely the distal suckers. Each membrane has very prominent, transverse, greyish-white or darker coloured thickenings, alternating with the suckers. These thickenings have an irregularly folded or wrinkled surface, which may be partly due to contraction during fixation. The chitinous rings of the arm-suckers show numerous fine denticles. All the arms are laterally compressed with an outer swimming-membrane along their whole length. The distal parts of these membranes bear sometimes a few papillae on their outer borders, as in *Sepia papuensis*.

The tentacles are very long and slender with rather short clubs. The exact arrangement of the tentacular suckers is difficult to ascertain, their total number attains about 40. Probably there are 5 or 6 longitudinal series. Four median suckers are much larger than the other ones, long-stalked and each situated in a deep pit; two of them may attain 5.6% of the mantle-length in the smallest specimen. At the dorsal side of each big sucker are two minute suckers, at the ventral side two or three bigger ones, the largest of which attains about one-third of the diameter of the big median suckers. In the small specimens the chitinous rings are finely dentate, but in the bigger ones the rings of the big suckers are smooth. The swimming-membrane is very wide along the tentacular club, but becomes gradually narrower along the tentacular stem; its whole length is about twice that of the club. The protective membranes are thin and narrow, separated at their bases and continuing on the inner surface of the stem beyond the swimming-membrane. The dorsal membrane is separated from the stem of the club by a deep groove, but there are no fenestrae opposite the big suckers as in *Sepia chirotrema*.

Even the smallest of these four female specimens has well-developed nidamentary glands; unfortunately the male is unknown.

The shell does not differ from that of the holotype. In well-preserved specimens the posterior end is more acuminate; it shows at its ventral surface the radiating calcareous streaks which pass from the rounded angle of the inner cone outwards on the horny termination. This is probably the calcification which according to Iredale (1926a: 240) suggests a spine formation in the largest specimen of his sub-species *laxior*.

## Remarks

According to Hoyle (1886: 148) 'In *Sepia pfefferi* the pits at the base of the funnel for articulation with the mantle are deepest in the middle, not at the anterior end as in *Sepia tullbergi*.' In the small specimens these pits are in fact situated about in the middle of the funnel cartilages, but in the larger specimens they are in front of the middle.

Iredale (1926a: 240, pl. XXXV, figs 9, 10) described a sub-species *laxior* for a broader shell, found in the Capricorn Group at the southern end of the Great Barrier Reef. In 1954 (p. 78) he mentioned this sub-species from other localities along the Queensland coast and stated that Whitley collected specimens of a different form at Denham, Shark Bay, Western Australia. For the Shark Bay form, Iredale (1954: 78, pl. V, figs 9, 10, 11) introduced the sub-species name *wanda*. These sub-species are only based on the shells, the animals have not been described. According to Iredale (1954, p. 78) the western form shows little calcification of the inner limbs, while in the eastern form the inner limbs are well calcified. In well-preserved shells both the anterior and posterior ends are rather acuminate, but these chitinous portions may be easily worn or damaged in beach-collected shells or in shells extracted from the animals, which changes the relative width. The inner limbs of the above-described specimens are normally calcified. Consequently I do not see any reason to separate the specimens described by Iredale as a western and an eastern sub-species.

## SUPPLEMENTARY NOTE

Included in the Western Australian Museum collections sent to me for study were specimens of three species from non-Western Australian localities but which are worth reporting.

### *SEPIA MESTUS* GRAY, 1849

(Plate 9, Fig. 3)

*Sepia mestus* Gray, J.E., 1849: 108

Tryon, G.W., 1879: 197

Hoyle, W.E., 1886: 135, fig. 5

Brazier, J., 1892: 12

- Tate, R. & May, W.L., 1901: 351  
 ?Chapman, F., 1912: 25  
 Hedley, Ch., 1918: M.33  
 Adam, W., 1939: 52, 86  
 Adam, W. & Rees, W.J., 1966: 45, pl. 13, fig. 74-75; pl. 14, fig. 76-79; pl. 15, fig. 80-83; pl. 46, fig. 274  
*Ascarosepion verreauxi* Rochebrune, A.T. de, 1884: 98, pl. V, fig. 2  
 Adam, W., 1944: 229  
*Solitosepia liliana* Iredale, T., 1926: 188, pl. XXI, fig. 1-3; 1954: 64  
 Iredale, T. & McMichael, D.F., 1962: 98

#### Type localities

Australia (*S. mestus*); Sydney (*S. verreauxi*); Manly Beach, N.S.W. (*S. liliana*).

#### Geographical distribution

Southern Queensland and New South Wales, eastern Australia.

### MATERIAL

#### Dry specimens

- 1 Flinders Beach, near Amity, Stradbroke I., Qld; June 1973; WAM 810-75: 2 spec. (Plate 9, Fig. 3).

TABLE 18  
 Measurements of *Sepia mestus*

Shell (in % of shell-length)					
Loc.	L. in mm	W.	Th.	Str.z.	Spine
1	74	44	8.1	69	5.1
1	68.2	41	9.8	65	5.8

#### Description

The shell is oval, broadest in its posterior half, slightly acuminate at the anterior end and with a strong, ventrally keeled, posterior spine, which is slightly directed upwards. The dorsal surface is convex with a faint indication of an indistinct median rib. Nearly the whole dorsal surface is reticulate

granulose, this granulation being strongest near the posterior end and on the outer cone. The ventral surface is rather flat with a very narrow, shallow, median groove in the striated area; this groove being slightly wider on the last loculus. The striae are regularly convex and very close together. The limbs of the inner cone are very large in their posterior half and are completely fused to the outer cone. The lateral parts of the outer cone are broad and continuous behind the inner cone as a narrow margin. The spine has a high wedge-like ventral keel.

### Remarks

As mentioned by Adam & Rees (1966: 46), the animal of this species is not known for certain. They described a badly preserved female specimen from Northern China which seems to belong to this species.

The specimens described and figured by Iredale (1926: 189, pl. XXI, fig. 4-5) as '*Solitosepia mestus*' do not seem to belong at all to this species. On the other hand I do not doubt that '*Solitosepia liliana* Iredale, 1926' is synonymous with the true *Sepia mestus* Gray.

### *SEPIA PLANGON* GRAY, 1849

(Plate 6, Fig. 2)

*Sepia plangon* Gray, J.E., 1849: 104

Tryon, G.W., 1879: 194

Hoyle, W.E., 1886: 128

Brazier, J., 1892: 11

Hedley, C., 1918: M.33

Adam, W. & Rees, W.J., 1966: 42, pl. 13, fig. 70-73; pl. 44, fig. 267

*Acanthosepion plangon* Rochebrune, A.T. de, 1884: 105

Adam, W., 1944: 231

*Solitosepion plangon* Iredale, T., 1926: 190, pl. XXIII, fig. 3-4; 1954: 66

Iredale, T. & McMichael, D.F., 1962: 98

*Solitosepia plangon adhaesa* Iredale, T., 1926a: 238

?*Sepia cultrata* Hedley, Ch., 1918: M.33 (non Hoyle, 1886)

?*Sepia polynesica* Pfeffer, G., 1884: 11, fig. 14, 14a

### Type localities

Port Jackson, Australia (*Sepia plangon*); North-West I., Capricorn Group (*S. plangon adhaesa*).



## Geographical distribution

Eastern Australia (southern Queensland, New South Wales, Lord Howe Island).

## MATERIAL

### Dry specimens

- 1 Flinders Beach near Amity, Stradbroke I., Qld; June 1973; WAM 802-75: 2 spec. (Plate 6, Fig. 2)

TABLE 19

Measurements of *Sepia plangon*

Shell (in % of shell-length)

Loc.	L. in mm	W.	Th.	Str.z.	Spine
1	95.5	31	7.7	73	4.7
1	63.4	28.5	8.6	66	4.7

### Description

Both shells are rather worn but they certainly belong to this species. In each the spine possesses a ventral keel and is distinctly curved upwards. See Adam & Rees (1966: 42-43) for a full description of this species.

## *SEPIA BANDENSIS* ADAM, 1939

*Sepia bandensis* Adam, W., 1939: 1, fig. 1-4; 1939a: 53, pl. III, fig. 4-5  
Adam, W. & Rees, W.J., 1966: 104, pl. 26, fig. 165-168; pl. 44, fig. 266

### Type locality

Banda Neira.

### Geographical distribution

Central Indo-West Pacific.

## MATERIAL

### Spirit specimen

- 1 Little Lagoon, Sibutu, Sulu Arch., Philippines (4°31'N, 119°22'E), on reef sand flats at low tide at night; February 1964; WAM 468-65: 1 ♂. 1 ♀.



TABLE 20  
Measurements of *Sepia bandensis*, shell (in % of shell-length)

Loc.	Sex	L. in mm	W.	Th.	Str.z.
1	♂	43.5	44.5	9.2	64
1	♀	42	51.5	10.5	66.5

### Description

The poor preservation of the animals does not permit a detailed description and exact measurements, but there does not seem to exist any noteworthy difference with the type material. The shells show exactly the same characters.

### ACKNOWLEDGEMENTS

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## NOTES ON THE FRESHWATER FAUNA OF NORTH-WESTERN AUSTRALIA, ESPECIALLY THE KIMBERLEYS

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### ABSTRACT

Notes on the freshwater fauna of north-western Australia including the Kimberleys are given based on fragmentary collections made May and June 1965. The collections do not support the idea that the region constitutes a distinct fluvifaunula province. Amphipods and stoneflies appear to be absent. Faunal diversity in streams seems low.

### INTRODUCTION

The reason so little is known of the freshwater fauna of north-western Australia is clear: the region is amongst the most inaccessible and least densely populated parts of Australia. There are many reasons, however, why this region is of interest to biologists. It is well within the tropics and, for Australia, has a large annual rainfall with a marked and reliable seasonal periodicity; a great part of it lies over 500 m above sea-level (the Kimberley Plateau) and has many permanent surface waters; and it is isolated by extensive arid and semi-arid areas from southern regions of similarly plentiful permanent water, but lies only about 500 km from the well-watered island of Timor — part of a different zoogeographical realm.

A little information on the freshwater fauna is available from Dr E. Mjöberg's Swedish Scientific Expedition in 1910, and the more recent expedition to the north-western Kimberleys (Prince Regent River Reserve) in August 1974 (Miles and Burbidge, 1975). The present note summarizes information from a small number of samples taken incidentally in May and June 1965. Some frogs collected at the same time by Dr A.K. Lee (Monash

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University) are also considered. Some of the results have already been published: Bayly (1966) has discussed the calanoid copepods, McKenzie (1966) the ostracods, and Williams and Buckney (1976) the chemical composition of surface waters. This paper provides a synopsis of both published and hitherto unpublished results.

## DESCRIPTION OF REGION

Several general accounts refer briefly to surface waters, e.g. those of Easton (1922), Field (1934), Christian and Stewart (1953), Morgan (1955), Patterson (1960), and Stewart and Speck (1960). Hydrogeological information upon parts of the Kimberley region is given by Morgan (1963), Passmore (1964) and Allen (1965). Jennings and Sweeting (1963) provide some chemical data for waters in the Fitzroy River Basin, but the most comprehensive account of the chemistry of surface waters is that of Williams and Buckney (1976). Summarizing their results, it is noted that the salient feature of all flowing waters in the Kimberleys was their extremely low salinity; most (5) had  $K_{18}$  values of  $< 25 \mu\text{mhos}$ , one had a value of  $160 \mu\text{mhos}$ . Standing waters sampled likewise were very fresh; all had  $K_{18}$  values  $< 500 \mu\text{mhos}$ . Ionic dominances in both standing and running waters showed no consistent patterns. However, in general sodium or magnesium were the most abundant cations and calcium and potassium the least; sulphate was almost always the least abundant anion and bicarbonate the most. Williams and Buckney (1976) explain the low salinity of waters in the Kimberleys in geochemical and physio-graphical terms: the largely igneous rocks are Precambrian and long subject to leaching, and high average annual rainfall, rapid run-off and efficient drainage moderate evaporative concentrating effects due to high mean air temperatures.

Christian and Stewart (1953), Slatyer (1960), and Fitzpatrick and Arnold (1964) discuss the climate. It is arid-monsoonal in the north and semi-arid elsewhere — respectively, CA'w and DA'w in the Thornthwaite classification of climates (see Keast, 1959). Most rain falls November to April (summer). Part of the north-west has an annual average of  $> 125 \text{ cm}$ , and most of the north  $> 60 \text{ cm}$ ; elsewhere it is 40 to 60 cm. Evaporation is always high, mean annual values ranging from ca 200 cm in the north to ca 260 cm in the south. Thus, mean annual potential evapo-transpiration greatly exceeds precipitation almost everywhere; only in a very small area of the extreme north-west is this not so. Mean monthly temperatures are continuously high; in January (mid-summer), they exceed  $26^{\circ}\text{C}$ ; in July (mid-winter), they vary from  $< 21^{\circ}\text{C}$  in the north to ca  $18^{\circ}\text{C}$  in the south.

Geological accounts for most of the region are given, *inter alia*, by Traves (1955) (Ord-Victoria area), Guppy, Linder, Rattigan and Casey (1958) (Fitzroy Basin), Speck (1960) (north Kimberley region and Fitzroy Basin) and Wright (1964) (West Kimberley region). In summary, the northern and central Kimberleys consist almost entirely of rocks of Upper Proterozoic age (mainly sandstones, quartzites, basalts, dolerite), the east Kimberleys and adjacent north-western part of the Northern Territory mainly of Cambrian and Proterozoic rocks (chiefly



limestones with interbedded shales and sandstones, quartzites), and the southern and south-western areas (mostly, the Fitzroy Basin) of rocks of Palaeozoic or Triassic age (conglomerates, limestones, sandstones, shales) and Quaternary alluvia.

In general, permanent surface waters are plentiful throughout the region, and particularly so in the north-west. Indeed, the Kimberleys, according to several authors (e.g. Patterson, 1960) is the best permanently watered area of northern Australia. Permanent running waters are mostly confined to the northern Kimberleys; elsewhere running waters occur only after the wet season with the exception of a few fed by perennial springs. Most standing waters lie in basins located along drainage systems and become part of such systems in the wet season.

## METHODS AND RESULTS

Most collections were made with a pond hand-net in conventional manner or with a zooplankton cone net. Rotenone, a fish poison, was used once. The location of collections is indicated in Fig. 1, and, for brevity, localities mentioned in the text are referred to by number (except where frogs were collected). For convenience and consistency with McKenzie (1966) original station numbers are retained.

It has not been possible to identify all specimens to species rank, and this will remain the case for some years pending taxonomic revision of various groups. As definitive a list as possible is given in Table 1.

## DISCUSSION

### (a) Pisces

Fish were collected at eight localities (Table 1), but except at one (Sta. 599), no special effort was made to catch fish. At Sta. 599, the whole locality was poisoned with Rotenone. The fish recorded provided no surprises. Most occur widely in northern Australia (Lake, 1971) and some also in New Guinea. In any event there are no contradictions to the statement that Australia lacks primary freshwater fish (with two notable exceptions; cf. Lowe-McConnell, 1975). The fish collected indicate that this applies even in permanent and very dilute fresh waters in the tropical region closest to a zoogeographical realm *with* primary freshwater fish. The theraponid species recorded was not unlike *Scortum barcoo* and was initially identified as that species. Subsequently this identification was discounted.

#### (b) Amphibia

Eight species of frog were collected (Table 1). All but one have previously been recorded from the area (Cogger, 1975). The exception is *Uperoleia marmorata* (Leptodactylidae); the record of this species extends its known distribution considerably northwards from those areas in Western Australia from which it has previously been recorded (the species also occurs in south-eastern Australia). Of the other species recorded, one is widespread throughout most of Australia, three occur throughout northern Australia (and, of these, one also in eastern Australia), and three in the Kimberleys and the northernmost part of the Northern Territory.

#### (c) Reptiles

Two species were collected (Table 1).

*Emydura australis* was collected at three localities. It is endemic to the Kimberley region, though is not the only freshwater tortoise recorded there. In view of Cogger's (1975) recent statement that its habit is unknown though thought to be similar to that of *Emydura macquarii*, it is of interest to record that Sta. 587 was a deep permanent lake forming part of the Fitzroy River, 598 a permanent river, and 599 a large and probably permanent billabong associated with 598. Cogger's statement appears correct.

*Crocodylus johnstoni* was collected at Sta. 598. It was also reported from Sta. 587 (Geikie Gorge) but both this report and a report of the estuarine crocodile (*C. porosus*) in the same locality are unconfirmed by specimens. Cogger (1975) notes that both species occur in a wide arc across northern Australia, including north-west Australia.

#### (d) Hirudinea

A single freshwater leech was collected (Sta. 597). Its species identity remains unknown. It may be a member of the barbroniid group but the typical copulatory pits of this group appear absent (L.R. Richardson, pers. comm., 21 September 1976).

#### (e) Mollusca

Three bivalve species were collected: a representative of the widespread *Corbiculina*, and two species of the mussel *Velesunio* (Table 1). With one exception, the records of *Velesunio* fall within known distribution ranges (McMichael and Hiscock, 1958). The exception is the record of *V. wilsonii* from Sta. 582; this record now links up the two known regions of distribution of this species in north-west Australia (McMichael and Hiscock, 1958).

Gastropods were collected thrice (Table 1). Though fragmentary, the record of *Lymnaea* in the Kimberley region east of the Ord Dam is of some medical and agricultural significance in view of the fact that certain species of the genus may serve as intermediate hosts for trematode parasites (cf. Charters, 1975). Note may also be made here of the recent remark by Wilson and Smith (1975: 97): 'No species of freshwater snails known to be vectors of schistosomiasis have yet been found in the Kimberley, but snails closely related are present.' Only one species of freshwater lymnaeid gastropod was collected by these authors from the Kimberleys who identified it as *Lymnaea tomentosa*. This species identification now seems to have been an error according to Dr B.R. Wilson (pers. comm., 8 December 1977). Studies on the identification of the Kimberley *Lymnaea* are proceeding at the Western Australian Museum.

(f) Sundatelphusidae

Freshwater crabs were collected at three localities. All were *Holthuisiana transversa* and fall well within the known range of that species (Bishop, 1963).

(g) Palaemonidae and Atyidae

One genus in each family was recorded (Table 1). The records extend the known generic distributions but in an expected fashion. Thus, the records of *Macrobrachium* relate to an area bordered north and south by previous records, and those of *Caridina* provide expected extensions to the record of its presence near Darwin (N.T.) (see Bishop, 1967).

The *Macrobrachium* specimens belonged to three species: *M. rosenbergi*, *M. tolmerum* and *M. australiense cristatum*. These showed clear geographical separation except that at one locality, 603, both *M. rosenbergi* and *M. tolmerum* coexisted. The occurrence of *M. rosenbergi* at this locality is not surprising for this species is known to penetrate fresh waters but require estuarine conditions to breed; locality 603 was not far from such conditions. *M. tolmerum* was found only in the northern part of the Kimberleys; *M. australiense cristatum* occurred in the more southern localities. Both *M. australiense* and *M. tolmerum* have previously been recorded from north-western Australia (Ord River) by Mr T. Walker (pers. comm., 4 August 1976), and these records and the present ones indicate that both species are more widespread in Australia than previously published records would suggest. The occurrence of *M. rosenbergi* is not the least surprising; the species is known from brackish or coastal fresh waters in south-east Asia

and Australia. In view of Riek's (1951) statement for *M. tolmerum* that 'on the size of the eggs one would be of the opinion that this was an estuarine species of the genus' it should be noted that all localities from which it was recorded in the Kimberleys were markedly fresh, and some were upstream of substantial waterfalls (on the King Edward River). There seems little doubt that *M. tolmerum* is a true freshwater species of *Macrobrachium*.

*Caridina* specimens appeared to belong to two species. Neither species unequivocally fits species descriptions of known Australian species, but it is noted that Riek's (1953) revision of Australian Atyidae is no longer considered adequate.

#### (h) Ostracoda

Ostracods were collected from 13 localities (Table 1). Sixteen species were recorded, 6 new to science. McKenzie (1966) has dealt with the material comprehensively. Here it need be noted only that all species belonged to known genera, and that the records of the European and African genus *Isocypris*, the Indonesian and African genus *Hemicypris*, and the southern hemisphere genus *Strandesia* were the first for Australia. The species records also included several previously known only from eastern Victoria.

#### (i) Copepoda

Of free-living copepods, only calanoids have been examined in detail. The results formed part of the basis of the paper by Bayly (1966) which reviewed the taxonomy and distribution of Australian species of *Diaptomus*. Two species of *Diaptomus* are known from Australia, *D. (Eodiaptomus) lumholtzi* and *D. (Tropodiaptomus) australis*. Of these, the former was recorded at fifteen localities and the latter at one (Table 1). All records considerably extended the known Australian generic distribution.

*Boeckella triarticulata* was recorded at two localities, both well north of the previously known generic limit. At one (Sta. 578, Lake Woods), *D. lumholtzi*, *B. triarticulata* and *Calamoecia lucasi* coexisted. This was the only locality at which *Calamoecia* was collected, indicating the absence of this genus from north-western Australia despite its presence in north-eastern Australia and New Guinea. The co-occurrence of *D. lumholtzi* and *B. triarticulata* does not invalidate the general thesis that *Diaptomus* is a genus of northern distribution whereas *Calamoecia* and *Boeckella* are genera of predominantly southern distribution.



(j) Cladocera

No attempt was made to collect Cladocera widely but a large collection from one locality (Sta. 596) was obtained. This contained a great variety of taxa: at least ten genera and twelve species (Table 1). One of the genera (?*Pseudosida*) and one species (*Pleuroxus ?reticulatus*) have not hitherto been recorded from Australia. Two species at least, *Chydorus barroisi* and *Ilyocryptus spinifer*, are common in Australia.

(k) Insecta

The insect collections are quite fragmentary. However, representatives of six orders were obtained (Table 1): Hemiptera, Odonata, Coleoptera, Ephemeroptera, Diptera and Trichoptera. Although these were obtained without special effort, determined efforts were made to collect plecopteran nymphs and adults. None was found (see Conclusions below).

Representatives of all the major aquatic Hemiptera families were found, namely Nepidae, Corixidae, Notonectidae, Naucoridae, Belostomatidae and Gerridae. With one exception, all taxa recorded are either widespread in northern Australia or are Australia-wide in distribution and thus of little zoogeographical interest apart from extending the known distributions of some forms. The exception is *Nychia ?marshalli*, a species widespread in south-east Asia. It has previously been reported from the Kimberleys (Hale, 1925) but is not found elsewhere in Australia.

Five odonate taxa were recorded: none is restricted to north-western Australia, and they occur widely beyond that region. Most Kimberley Odonata have distributions of this sort (Watson, 1974): indeed only 4 species are known from the Kimberleys alone. The remaining 53 are found also in the Northern Territory and New Guinea (4 spp.), north-eastern Queensland (1), the Northern Territory and north-eastern Queensland (46 — including some very widespread forms), and Hamersley Ranges (1). The same general comment applies to the two beetles identified to species.

Rather greater interest attaches to the limited (and damaged) ephemeropteran material. This included two separate species of Caenidae, one in the genus *Tasmanocoenis* (the only known Australian genus in the family), the other of uncertain generic position. It is very likely that one of these species, and possibly both, are new to science in view of Riek's (1970: 238) statement on the genus: 'The only Australian genus [of Caenidae], *Tasmanocoenis*, is found in Tasmania and on the mainland from the coastal plains to the subalpine zone of the Kosciukso Plateau; one species exists in

W.A.' (it is possible that the W.A. species mentioned is one whose description remains unpublished by Riek). Baetids have previously been recorded from the north-west of Australia (Riek, 1970).

TABLE 1  
Fauna recorded

Taxon	Station numbers*†
<b>Pisces</b>	
<i>Neosilurus glencoensis</i>	599
<i>Melanotaenia</i> sp.	597, 598, 599
<i>Ambassis agassizi</i>	580, 597, 599
<i>Madigania unicolor</i>	598, 599, 607
theraponid sp.	578, 598
<i>Glossogobius giurus</i>	587, 599
<i>Morgunda morgunda</i>	587, 596, 599
<b>Amphibia</b>	
<i>Litoria rubella</i>	Top Springs, N.T.; Hayward Ck; Woodhouse River Crossing, W.A.; King Edward Lake
<i>L. nasuta</i>	King Edward River
<i>L. rothi</i>	Admiralty Gulf; Langi Crossing, Fitzroy River; King Edward River
<i>L. inermis</i>	Woodhouse River Crossing; Camfield River; King Edward River; 40 km N of Gibb River Homestead; Fitzroy River Crossing; Langi Crossing, Fitzroy River
<i>L. coplandi</i>	King Edward River; Admiralty Gulf; 40 km S of Wyndham
<i>L. wotjulumensis</i>	King Edward River
<i>L. meiriana</i>	King Edward River
<i>Uperoleia marmorata</i>	Gibb River Station
<b>Reptilia</b>	
<i>Emydura australis</i>	587, 598, 599
<i>Crocodylus johnstoni</i>	598
<b>Hirudinea</b>	
barbronid sp.	597

\* See figure legends for details of position.

† Localities at which frogs were collected do not all correspond with other collecting localities. Original locality data are therefore given.



TABLE 1  
Fauna recorded

Taxon	Station numbers
Mollusca	
<i>Corbiculina</i> sp.	597
<i>Velesunio wilsonii</i>	582, 587
<i>V. angasi</i>	597, 598
<i>Plotiopsis australis</i>	587
<i>Lymnaea phillipsi</i> (?= <i>L. lessoni</i> )	586
? <i>Lymnaea</i> sp.	597
Sundatelphusidae	
<i>Holthuisiana transversa</i>	576, 577, 595
Palaemonidae	
<i>Macrobrachium rosenbergi</i>	603
<i>M. tolmerum</i>	593, 595-599, 602, 603
<i>M. australiense cristatum</i>	580, 581, 587
Atyidae	
<i>Caridina</i> sp.A	593, 595-598, 602, 604
<i>Caridina</i> sp.B	587, 595, 597, 598, 603, 604
Ostracoda	
<i>Ilyocypris australiensis</i>	575, 576, 580, 583, 584, 590, 593
<i>Newnhamia fenestrata</i>	576, 592
<i>Cyprinotus kimberleyensis</i>	591, 592, 594, 599
<i>Heterocypris sydneya</i>	580, 581
<i>Hemicypris</i> cf. <i>fossulata</i>	580, 581, 591
<i>H. megalops</i>	580, 581, 599
<i>Cypris</i> cf. <i>bennelong</i>	575, 583
<i>Isocypris williamsi</i>	583, 584, 590, 593
' <i>Strandesia</i> ' <i>dorsoviridis</i>	583, 590, 592
' <i>Eucypris</i> ' cf. <i>oblongata</i>	591
<i>Candonocypris fitzroyi</i>	590
<i>Cypretta</i> cf. <i>turgida</i>	576, 590, 591, 596
<i>Cypretta</i> sp.	593, 594
<i>C. bayli</i>	583, 594
<i>C. lutea</i>	584, 592
<i>Limnocythere aspera</i>	599
Copepoda	
<i>Diaptomus lumholtzi</i>	575, 576, 578-583, 587, 588, 591, 593, 594, 606
<i>D. australis</i>	597
<i>Boeckella triarticulata</i>	578
<i>Calamoecia lucasi</i>	578

TABLE 1  
Fauna recorded

Taxon	Station numbers
Cladocera	
<i>?Pseudosida</i> sp.	596
<i>Chydorus barroisi</i>	596
<i>Chydorus</i> sp.	596
<i>Alona</i> spp.	596
<i>Biapertura affinis</i>	596
<i>Alonella</i> sp.	596
<i>Camptocercus</i> sp.	596
<i>Pleuroxus ?reticulatus</i>	596
<i>Simosa (=Simocephalus)</i> sp.	596
<i>Ilyocryptus spinifer</i>	596
other macrothricids	596
Insecta	
Hemiptera	
<i>Ranatra dispar</i>	577
<i>Nychia ?marshalli</i>	587
<i>Anisops nasuta</i>	586
<i>A. semita</i>	586
Gerridae	586
<i>Micronecta</i> sp(p).	586, 580, 597
<i>M. cf. robusta</i> and <i>major</i>	575
<i>M. ?halei</i>	575
<i>Agraptocorixa parvipunctata</i>	604
<i>Naucoris</i> sp.	597
<i>Diplonychus ?rusticus</i>	597
Odonata	
<i>Pantala flavescens</i>	577
<i>Hemianax papuensis</i>	577
<i>Hemicordulia tau</i>	597
<i>Nannophlebia</i> sp.	597
<i>Diplacodes haematodes</i>	597
Coleoptera	
Dytiscidae sp(p).	575, 578, 580, 586, 587, 593, 597
<i>Eretes sticticus</i>	575, 578
<i>Hydrophilus</i> sp.	575
<i>?Hydrocanthus australasiae</i>	598
Ephemeroptera	
Baetidae	575
<i>Tasmanocoensis</i> sp.A	575
Caenidae (non <i>T. sp.A</i> )	580

TABLE 1  
Fauna recorded

Taxon	Station numbers
Trichoptera Leptoceridae	597
Diptera Tabanidae	587

## CONCLUSIONS

The faunal collections are too fragmentary for firm statements on the zoogeographical cohesiveness of the area or otherwise. However, as they stand they provide little support to the idea that north-western Australia comprises a distinct fluvifaunula region. Certain taxa do appear endemic to the region, but many form part of a widespread northern Australian assemblage of forms, and some occur, too, in the Indonesian Archipelago and beyond.

Two further, and rather more definite general points may be made. Firstly, specific searches were made for freshwater amphipods and plecopteran nymphs. Despite careful searches in a number of apparently suitable localities, no specimens were found. The apparent absence of plecopterans should be noted against the statement by Riek (1970: 317) that 'there are no records from the vast area of central, north, and north-western Australia, although there are probably some areas that would be suitable for stoneflies.' Bailey and Richards (1975) in their report on the insects of the north-western Kimberleys do not list any plecopterans amongst specimens collected.

Secondly, although most general faunal collections were fragmentary, at one locality, Sta. 597, a more thorough collection was undertaken. Here, the following groups were found (see also Table 1): Coleoptera, Odonata, Palaemonidae, Atyidae, Hemiptera, Ephemeroptera, Pisces, Reptilia. Notably absent were bivalve and gastropod molluscs, oligochaetes, and trichopteran, plecopteran and dipterous larval forms. The locality, a small stream, appeared permanent (as indicated by the presence of prawns), yet was remarkably depauperate in terms of faunal diversity *vis-à-vis* small permanent streams in south-eastern Australia. Possibly the extremely low salinity of the water (16 ppm) had an effect, but this is not regarded as a total explanation; Tasmanian streams as dilute have a much more diverse fauna.

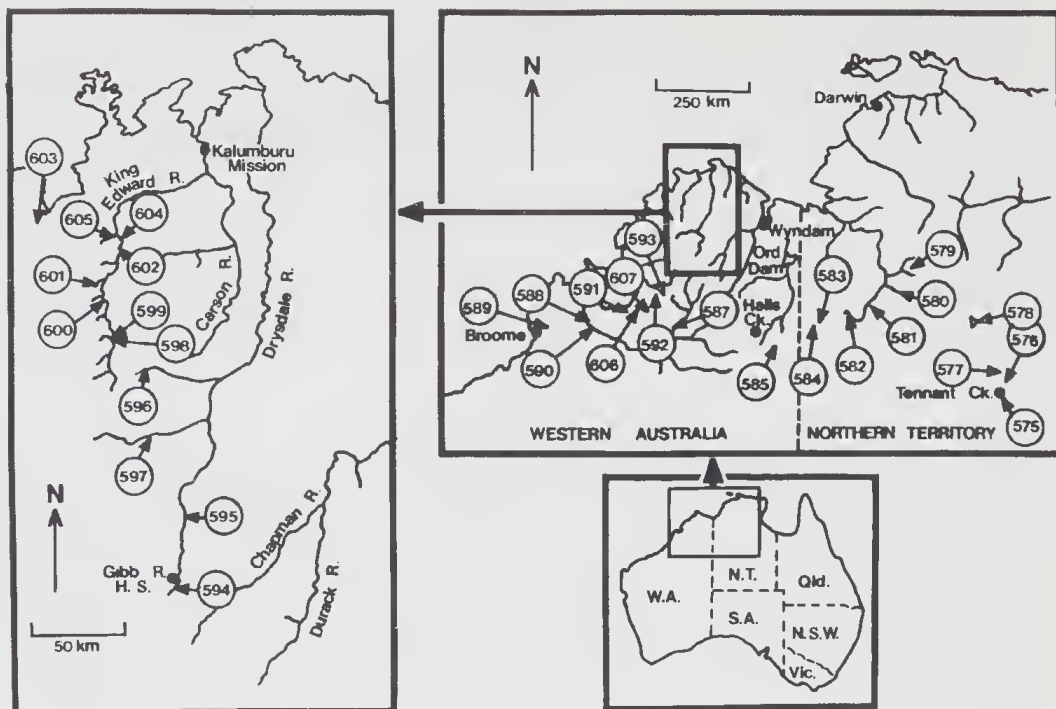


FIG. 1  
Position of sample localities

Index to station numbers: 575, water-holes in Tennant Creek; 576, water-holes in Hayward Creek; 577, water-holes in Morphett Creek; 578, Lake Woods, near Elliot; 579, water-hole in creek at Top Springs; 580, water-hole in Camfield River; 581, water-hole in tributary of Victoria River, 16 km west of Wave Hill; 582, deep pool in creek bed, about 80 km east of Inverway; 583, shallow pool in creek bed, about 16 km west of Inverway; 584, small, bore-fed, dam about 200 m from 583; 585, Mary River, about 110 km east of Halls Creek; 587, large, deep and permanent lake in course of Fitzroy River at Geikie Gorge, near Fitzroy Crossing; 588, mouth of Fitzroy River at Langi Crossing; 589, artificial dam about 3 km east of Broome; 590, large but shallow water-hole near junction of Broome, Derby and Fitzroy Crossing roads; 591, small, bore-fed, dam about 80 km east of Derby towards Mount House homestead; 592, deep rock-hole, about 95 km west of Mount House homestead; 593, water-hole in bed of creek, about 40 km west of Mount House homestead; 594, temporary, shallow pool in creek at Gibb River homestead; 595, small rock-hole about 40 km north of Gibb River homestead; 596, billabong of Crossland River about 16 km north of Sarsfield (= Drysdale) Crossing and south of Couchman Range; 597, Drysdale River at Sarsfield Crossing; 598, King Edward River; 599, billabong about 1 km south of locality 598; 600, tributary stream of King Edward River about 20 km north of 598; 601, tributary stream of King Edward River, about 30 km north of 598; 602, King Edward River, about 3 km south of Falls; 603, small stream entering Montegue Sound; 604, small isolated water-hole in rock at Falls on King Edward River; 605, quiet backwater of King Edward River at Falls; 606, water-hole in Lennard River at Winjana Gorge; 607, pool in cave, Tunnel Creek.

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## ARTIFICIAL BIAS IN A SAMPLE OF KANGAROO INCISORS FROM DEVIL'S LAIR, WESTERN AUSTRALIA

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### ABSTRACT

Discrepancies in the numbers of various kinds of teeth of the Western Grey Kangaroo (*Macropus fuliginosus*) among material excavated from Devil's Lair are demonstrated by comparing them to three other marsupial species. Some of these discrepancies can be related to biological characteristics of this species, but the greatest discrepancy, that between numbers of lower incisors and numbers of any other teeth, cannot. The most likely explanation is that the ancient human occupants of Devil's Lair were selectively removing lower incisors from the animals for use as implements or ornaments.

### INTRODUCTION

Devil's Lair is a small limestone cave near Augusta, Western Australia. It contains a deep, mainly sandy floor deposit in which excavations have revealed the presence of many bone and stone artifacts and of large quantities of bone, much of which is fragmented. These and other archaeological features suggest that humans occupied the cave at least intermittently, for the period 27,000-6,000 years B.P. (layers 28-9; Balme, Merrilees & Porter, 1978) and it is probable that most of the bone material from that part of the deposit represents prey of human hunters.

Disproportions in the quantities of different skeletal parts of the Western Grey Kangaroo (*Macropus fuliginosus*) from Devil's Lair have been noted by Baynes, Merrilees & Porter (1976). I have re-examined and extended their data by considering all *Macropus fuliginosus* material recovered from excavations up to and including 1976 (Dortch & Merrilees, 1973; Baynes, Merrilees & Porter, 1976; Balme, Merrilees & Porter, 1978). Comparative

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data on the Western Brush Wallaby (*Macropus irma*), the Brush-tail Possum (*Trichosurus vulpecula*) and the Common Ringtail (*Pseudocheirus peregrinus*) are also included. Through quantification of this data it is hoped to show the extent of the disproportions and to offer some explanations for the uneven representation.

Descriptions of these animals have been given by Ride (1970) and his nomenclature is followed. All four species are diprotodonts and have a pair of long lower incisor teeth. No Devil's Lair species matched *M. fuliginosus* in size but *M. irma* was included because it is the extant macropod in Devil's Lair nearest in size to *M. fuliginosus* and its dental characteristics were the closest comparison. The two possums were included because they are the two largest non-macropod species in the deposit whose dental characteristics offered the closest comparison to *M. fuliginosus*. The adult dental formula for both *Macropus fuliginosus* and *Macropus irma* is  $I_{1}^{3}, C_{0}^{0}, PM_{1}^{1}, M_{4}^{4}$  and for *Trichosurus* and *Pseudocheirus* the adult dental formula is  $I_{2}^{3}, C_{0}^{1}, PM_{1}^{1}, M_{4}^{4}$  (the second lower incisor of both the possums is extremely rudimentary).

## MATERIALS

Total numbers of selected teeth of the four species considered from excavations up to and including 1976 are shown in Table 1. For *Pseudocheirus peregrinus*, premaxillae with or without their incisors have been counted since the upper incisors of this species are small and fragile and may pass through the sieves or escape detection during sorting.

Table 1 shows less variation in the numbers obtained for skeletal elements of *T. vulpecula* and *P. peregrinus* than for *M. fuliginosus* and *M. irma*, in which not only lower incisors but also (less markedly) premolars and molars are not as well represented as upper incisors.

Distribution of each of the four species for layers of stratigraphically reliable context is shown in Table 2. The pooled mean age of the three earliest dates shown in Table 3 of Balme, Merrilees & Porter (1978) as 33,150, has now been recalculated to 32,800 shown in Table 2 (R. Gillespie pers. comm.).

### Uneven representation of the Devil's Lair material

In any archaeological or palaeontological bone sample of Macropodinae, variation in the representation of different teeth could occur because of natural tooth eruption, progression and replacement during an animal's

lifetime. For example, over-representation of incisors compared to cheek teeth could be because incisors erupt first in an individual's lifetime. An unerupted tooth is fragile, sometimes amounting to little more than a hollow shell of enamel. Many unerupted mammal teeth are therefore unlikely to survive as fossils and in an individual the earliest erupted teeth are likely to survive best.

To take account of this effect, I have compared the Devil's Lair Grey Kangaroo and Brush Wallaby teeth with specimens preserved intact in skulls or dentaries from the same region as Devil's Lair. Such comparisons make it possible to remove from the Devil's Lair sample all those incisors that can be construed as deriving from animals so young that their cheek teeth had not erupted at the time of their deaths. Table 3 shows the Devil's Lair sample so modified.

Table 1: Numbers of some skeletal elements from four marsupial species represented in Devil's Lair.

Skeletal element	<i>Macropus fuliginosus</i>	<i>Macropus irma</i>	<i>Trichosurus vulpecula</i>	<i>Pseudocheirus peregrinus</i>
left premaxilla				67
right premaxilla				68
LI <sup>1</sup>	56	18	81	
RI <sup>1</sup>	42	16	96	
LI <sup>2</sup>	29	8		
RI <sup>2</sup>	42	15		
LI <sup>3</sup>	26	15		
RI <sup>3</sup>	37	19		
LP <sup>3&amp;4</sup>	12	5		
RP <sup>3&amp;4</sup>	13	4		
LP <sub>3&amp;4</sub>	20	2		
RP <sub>3&amp;4</sub>	13	5		
LM <sup>1</sup>	15	12	110	157
RM <sup>1</sup>	8	11	88	131
LM <sub>1</sub>	13	6	119	172
RM <sub>1</sub>	11	2	101	181
LI <sub>1</sub>	4	1	113	151
RI <sub>1</sub>	3	1	103	136

To prevent animals represented by both deciduous and unerupted permanent premolars being counted twice, all deciduous premolars are included in the table but only fully erupted permanent premolars (i.e. having roots and showing some signs of wear) are included.





Table 2 (cont.)

	Radiocarbon date year B.P. 320	Western Grey Kangaroo							Western Brush Wallaby							Brush-tail Possum				Premaxilla			Ringtail Possum		
		I <sup>1</sup>	I <sup>2</sup>	I <sup>3</sup>	P <sub>3&amp;4</sub>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	I <sup>1</sup>	I <sup>2</sup>	I <sup>3</sup>	P <sub>3&amp;4</sub>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	I <sup>1</sup>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>			M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	
Z <sub>1</sub> 1 and 2 mixed		1	2														1	4	1			1	1	2	2
2 and 3 mixed																									
3 and 4 mixed		1														1	1	1	2			1			
4		2	4	1				1	1								3								
5																									
6		1	1	1				1				1					5	3	4	8			5	9	6
6 and 7 mixed																							1		8
7		2		1				1									2	2	6	3			7	6	4
7 and 8 mixed	19000																								5
8																									6
8 and 9 mixed																									7
9-upper brown part																									8
9-lower	19250	5	2					1			1						2	3	2	1			4	8	6
10a			1	1				1		1		2					3	2	1			1	5	10	
10b																						1	3		
10b and 10c mixed																									1
10c																									2
10d and 10e	20400																								3
11																									7
11 and 12 mixed																									2
12																									3
11, 12 and 13 mixed																									16
13																									14
14																									10
15																									3
14, 15 and 16 mixed																									2
16																									1
16 and 17 mixed																									2
17																									1
16, 17 and 18 mixed																									3
18 (inc. hearth)	(31400)																								2
19																									1
20																									1
21																									1
22																									1
23																									1
24																									1

Table 2 (cont.)

	Radiocarbon date year B.P. 320	Western Grey Kangaroo								Western Brush Wallaby								Brush-tail Possum			Premaxilla	Ringtail Possum		
		I <sup>1</sup>	I <sup>2</sup>	I <sup>3</sup>	P <sub>3&amp;4</sub>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	I <sup>1</sup>	I <sup>2</sup>	I <sup>3</sup>	P <sub>3&amp;4</sub>	P <sub>3&amp;4</sub>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	I <sup>1</sup>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	M <sup>1</sup>	M <sub>1</sub>	I <sub>1</sub>	
25		2							1	2	2			1			1	1			2		1	
26		4								1	1													
26 and 27 mixed																								
27 (inc. hearth)			1											1										
27 and 28 mixed	(24600																							
28 (inc. hearth)	(27700		1						1					1										
28 and 29 mixed																								
29			1							3											3			
29 and 30-upper mixed																					1			
30-upper																						2	1	
30-upper and																								
30-lower mixed																								
30-lower	32480																				3	6	2	
30-lower and																								
31 mixed																								
31	35160							1													1	4	3	
31 and 32 mixed																								
32																								
32 and 33 mixed																								
33																								
33 and 34 mixed*																								
34																								
34 and 35 mixed																								
35																								
35 and 36 mixed																								
37																								
38	31800								1															
38 and 39 mixed																								

\* pooled mean 32800

Table 3: Numbers of some *Macropus fuliginosus* and *Macropus irma* teeth from Devil's Lair (incisors of juvenile individuals excluded).

Tooth	<i>M. fuliginosus</i>	<i>M. irma</i>
LI <sup>1</sup>	19	9
RI <sup>1</sup>	17	13
LI <sup>2</sup>	17	8
RI <sup>2</sup>	22	11
LI <sup>3</sup>	15	11
RI <sup>3</sup>	22	14
LP <sup>3&amp;4</sup>	12	5
RP <sup>3&amp;4</sup>	13	4
LP <sub>3&amp;4</sub>	20	2
RP <sub>3&amp;4</sub>	13	5
LM <sup>1</sup>	15	12
RM <sup>1</sup>	8	11
LM <sub>1</sub>	13	6
RM <sub>1</sub>	11	2
LI <sub>1</sub>	4	1
RI <sub>1</sub>	3	1

To prevent animals represented by both deciduous and unerupted permanent premolars being counted twice, all deciduous premolars are included in the table but only fully erupted permanent premolars (i.e. having roots and showing some signs of wear) are included.

The high proportion of juvenile incisors in the deposit can also be explained in terms of the animal's biology. Almost all female kangaroos captured would be accompanied by at least one young. By analogy with the Eastern Grey Kangaroo, females old enough to have produced two young and carrying a pouch young less than 100 days old would also be accompanied by a juvenile (Kirkpatrick, 1965b). Such a family unit would provide a set of adult upper incisors, a set of juvenile upper incisors and many would also be represented by unerupted incisors.

In many macropods (including the kangaroo and wallaby discussed here) the molars, which erupt sequentially, move progressively forward in the jaw until one by one, they fall from the front of the molar premolar tooth row. Thus it is possible that premolar and molar teeth of older animals represented in the deposit would not all be present.

Furthermore, tooth replacement occurs in both macropods and phalangerids. Each of the four marsupials discussed here have two upper and

two lower deciduous premolars which are replaced by one upper and one lower premolar. Replacement usually occurs before all the molars have erupted. According to Tyndale-Biscoe (1973), all the premolars of the Red Kangaroo are shed during the first third of the animal's lifetime. Tooth replacement is slightly faster on the Eastern Grey Kangaroo than the Red Kangaroo (Kirkpatrick, 1965a), thus by analogy with the Eastern Grey Kangaroo, if the age distribution of kangaroos from Devil's Lair were normal, the number of premolars would be expected to be only one third the number of incisors. However, the high incidence of juvenile individuals from the deposit suggests a higher proportion than this can be expected.

On the basis of my own examinations of modern Western Australian Museum specimens, tooth replacement seems to be slower in the Brush Wallaby than the Grey Kangaroo. Thus under-representation resulting from tooth replacement is probably not as important as for the Grey Kangaroo.

The greatest discrepancy shown in Table 3 is between the numbers of *M. fuliginosus* upper incisors and lower incisors. Actually the discrepancy between upper and lower incisors is much greater than suggested in Tables 1 and 3 in which there is an implication that many of the left teeth represented come from the same individuals as many of the rights. However, attempts to match each right and left first upper incisor of the Western Grey Kangaroo from trenches 2, 5, 7, 8, and 9 show that very few of the teeth are from the same individual. Each right and left first upper incisor was examined for wear and general morphology in an effort to find matching pairs. Of the 60 teeth examined (32 left and 28 right), no matches were entirely convincing although two possible pairs were found.

The implication of this study is that the number of individuals of Grey Kangaroo represented in the whole deposit (Table 1) is probably closer to 98 (LI<sup>1</sup> 56 and RI<sup>1</sup> 42) than 56, and that of the 196 lower incisors therefore expected from the sample, only seven have been found.

In all incisor bearing kangaroo specimens from the fossil and modern collections of the Western Australian Museum, upper and lower incisors were generally found to be in about the same stage of eruption in the same individual. Thus, unless dentaries do not preserve as well as maxillae in a cave environment, the number of lower incisors should be at least as great as the number of first upper incisors.

To test the possibility that maxillae may preserve better than dentaries in caves, counts of Western Grey Kangaroo premaxillae, maxillae and dentaries were made on collections from two caves near Devil's Lair not suspected of having an archaeological component (cave AU12 near Augusta and Dingo or

'Boy Scout cave'). The results in Table 4 suggest that dentaries are selectively preserved with respect to maxillae and even more so when compared to premaxillae. Thus it seems reasonable to expect numbers of lower incisors to be at least as great as first upper incisors.

Table 4: Numbers of some skeletal parts of *Macropus fuliginosus* from two non-archaeological sites near Devil's Lair.

	Cave AU 12 near Augusta	Dingo 'Boy Scout' cave W1 71
premaxillae	2	2
maxillae	11	2
dentaries	13	7

The apparent discrepancy between numbers of first upper incisors and other teeth of Brush-tailed Possum and between the number of premaxillae and other skeletal structures of the Ringtail could not be reconciled. It is suspected that some of the Brush-tailed Possum first incisors may have been mis-identified as rat kangaroo upper first incisors. Ringtail premaxillae are fragile and the low numbers recorded may be a result of selected preservation. Thus, comparisons of numbers of lower incisors were made with numbers of upper first molars and there is no apparent discrepancy between these two structures. However, the discrepancies between the numbers of lower incisors and upper incisors of the Western Grey Kangaroo and Brush Wallaby remain striking.

#### The bone artifacts from Devil's Lair

A number of bone artifacts have been recognised from layers at Devil's Lair dating from about 30,000 years ago to 6,000 years ago. Many of these are just splinters but others show that bone was used by the human occupants of Devil's Lair to perform a variety of functions. These include invasively flaked or scratched pieces and several bone points. Some of these points are quite small (one apparently made on a bird fibula is only 14 mm long) but at least two are modified macropod fibulas (Dortch & Merrilees, 1972; Dortch & Merrilees, 1973).

Two artifacts whose probable function is decorative have also been excavated. The first is a small length of polished bone with rounded ends which has been interpreted as a bead and the second, a small pointed fragment with a perforation at one end has been suggested to be a needle

or bodkin or perhaps part of a necklace or headband (Dortch & Merrilees, 1973).

A few tooth artifacts have also been reported and so far all are macropod lower incisors. Most of these have been interpreted as artifacts because they have narrow, relatively deep incisions (Dortch & Merrilees, 1972) but at least one has been worked at its proximal end (Dortch & Merrilees, 1973).

#### Other archaeological evidence for the use of macropod teeth by Aborigines

Archaeological evidence for special use of kangaroo and wallaby incisors by Aborigines also occurs at two sites excavated by Carmel White in Arnhem Land. In the Padypadiy deposit, which dates from about 3,000 years B.P. to present, White (1967) has recorded the presence of ground kangaroo lower incisors throughout the deposit. From Malangargerr she has excavated two wallaby incisors bearing use gloss (one worn and broken) in contexts dating from 6,000 years B.P. to present (Mulvaney, 1975).

At Durras North, New South Wales, Lampert has only found one tooth of the 96 other wallaby teeth expected from the number of individuals estimated by the eight wallaby lower incisors excavated (Lampert, 1966). Three of the lower incisors have broken tips and Lampert has concluded that wallaby lower incisors were probably used either as ornaments or tools at Durras North.

#### Ethnographic evidence for the use of teeth by Aborigines

Ethnographic reports show that the use of teeth as tools and ornaments is widespread. In Australia wallaby and kangaroo lower incisors were particularly important and ethnohistorical data on their use records a variety of functions. For south-western Australia Nind (1832) noted this special importance by recording in an account of kangaroo butchering techniques of the Aborigines of King George Sound that the first operation was the extraction of lower incisors which were used to sharpen spear points.

As ornaments, lower incisors have been described from all over the continent. An ornament worn by both male and female Queensland Aborigines made by fixing the kangaroo incisors in a more or less oval shaped base of spinifex or beefwood cement has been recorded by Roth (1897). Spencer (1922) has described similar decorations as well as necklaces, forehead bands and other head ornaments. The Western Australian Museum ethnological collection contains many such ornaments.



McCarthy (1970) noted that although the mandible of various marsupials with their lower incisor intact was used as engraving tools and drills, possum and macropod lower jaws were especially used for such functions. The incisor has been described as a scraper by Roth (1904) for the Cape York people who broke the tooth after heating it and then used it either *in situ* in the lower jaw or bound on a wooden handle to sharpen speartips or cut grooves.

Another record of the incisor's use as a scraper comes from Mrs Hassell's descriptions of a tool used by the Aboriginal women of the Wheelman tribe, south-west Australia. Hassell (1936, p. 691) says that the women used a knife consisting of 'a stick with a kangaroo tooth embedded at one end. It was used in scraping skins, cutting sinews, and for skinning. The women were able to skin a kangaroo with it as rapidly as a man with a European knife'. The 'front tooth' in an engraving tool also described by Mrs Hassell probably refers to a lower incisor (Hassell, 1936; p. 692).

Although records vary as to the function of kangaroo incisors attached to spearthrowers, it is still the most commonly reported use of them. According to Eyre (1845, vol. 2, pp. 306-307) the Australian throwing stick is more or less the same throughout the continent. Although varying slightly in width or shape all are characterised by a mounted kangaroo tooth in the proximal end to act as a hook. However, Smyth (1878) records that in Victoria, throwing sticks sometimes had a carved wooden hook and in Western Australia they always had a wooden hook.

Specific Western Australian accounts for the use of kangaroo teeth in spearthrowers is also confused. Roth (1902) referring to information gathered by F.R. Austin, then the Assistant Surveyor for the South West of Western Australia, reported that spearthrowers from Port Leschenault, Koombana Bay area (where Bunbury now stands) had a kangaroo tooth fixed with gum at the distal end acting as a hook.

However, other accounts from the same area describe the function of the kangaroo tooth in the spearthrower as a knife or scraper rather than as a hook. For example, Davidson's Western-Southern type of spearthrower is made of hard wood, is relatively long and bi-convex in cross section, and usually has a gum handle which often contains a stone blade or a tooth knife (Davidson, 1936; p. 474).

In the Bremer Bay area this function is confirmed: 'spears were usually thrown with the aid of a meera or spearthrower, generally made of "raspberry jam" wood . . . the peg was a small wooden pin about one half



**A**



**B**

**FIG. 1**

- A:** South-west Australian spearthrower showing position of kangaroo lower incisor at distal end (WAM 361).
- B:** Enlargement of distal end of spearthrower showing lateral positioning of kangaroo incisor in gum.

inch long fastened to one end with gum and kangaroo sinew. The other end of the meera had a piece of gum for a handle. A kangaroo tooth was often embedded in the gum for use as a knife' (Hassell, 1936; p. 691). Moore (1842) reports a similarly mounted incisor which was used for a variety of purposes including scraping the points of spears.

All intact South West spearthrowers in the Western Australian Museum collection have a wooden hook and all except one have either lost the knife/scrapper from the gum handle or have never had one. The only specimen which had anything set in its gum contained a kangaroo lower incisor (WAM 361 — see Fig. 1).

The lateral positioning of the tooth suggests it was a scraper and the tip of the tooth is virtually unmarked while the exposed side of the tooth is heavily worked suggesting the tooth has always been mounted lengthways. None of the ethnographic accounts record the positioning of the lower incisor in the gum.

## DISCUSSION

Uneven representation of various skeletal elements has been found on both archaeological and non-archaeological sites. Goede and Murray (1977) believe the relative scarcity of small mammal remains and small skeletal parts of larger mammals from Pleisto Scene cave, north-west Tasmania is a result of differential preservation in favour of larger bones. The cave does not appear to have been used by humans, but some effects by scavengers or carnivores were suspected.

Archer (1974) has demonstrated by laboratory experiments and from field studies that differential transportation of bones by water can occur. Although it is possible that differential transportation has occurred in Devil's Lair and indeed has been suggested to have occurred in the lower part of the deposit (Balme, Merrilees & Porter, 1978), it seems unlikely to be the sole cause of the relative scarcity of kangaroo and wallaby lower incisors.

Brain's (1967) comparisons of the relative proportions of skeletal parts in the food remains of the Topnaar Hottentot villagers showed that some structures survive destructive treatment better than others. It is possible that trampling and crushing may have destroyed some of the small or more delicate bones in Devil's Lair, but it is difficult to envisage such actions selectively destroying a durable skeletal element such as the lower incisor of a kangaroo or wallaby.

The major predators of kangaroo at Devil's Lair are the Tasmanian Tiger (*Thylacinus cynocephalus*) and Man. The Tasmanian Devil (*Sarcophilus harrisii*) may also have contributed to the kangaroo sample by occasionally capturing a young, wounded or sick animal, but it is doubtful that it could catch a healthy adult kangaroo. Reworking of the food refuse of these animals by smaller carnivores is also possible, but although any of the carnivores may have selected bone in such a way that the bone sample is non-random, only Man is likely to have selected lower incisors to such an extent.

## CONCLUSION

A number of artifacts made out of kangaroo and wallaby bones (some on lower incisors) have already been recorded from Devil's Lair. Of the seven Grey Kangaroo lower incisors excavated from the deposit, four have their pointed tips broken off, suggesting perhaps that they were discarded being no longer useful as a tool.

In the light of this and of the available ethnohistorical evidence, the most plausible explanation for the low numbers of kangaroo and wallaby incisors from Devil's Lair is deliberate selection of the incisors by the early occupants of the cave. Kangaroo remains are consistently present in the cave from layer 29 to layer G representing a span of some 20,000 years (Table 2). The scarcity of kangaroo and wallaby incisors from these layers suggest that humans in the Devil's Lair region have been using the teeth as tools or ornaments from about 27,000 to at least 6,000 years ago.

## ACKNOWLEDGEMENTS

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## BROAD OVAL AUSTRALITE CORE FROM MUNTADGIN, WESTERN AUSTRALIA

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### ABSTRACT

The combination of unusually large size and relatively unweathered condition of an australite from Muntadgin, Western Australia has made possible an assessment of the form, dimensions and mass of the primary body from which it was developed. The primary body approximated to a triaxial ellipsoid of dimensions *c.* 77 x 62½ x 40 mm and mass *c.* 245 grams. The retention of a small part of the aerothermal stress shell on the anterior surface of flight of the australite is suspected.

### INTRODUCTION

An unusually large australite (Australian tektite), registered no. 13 396 in the Western Australian Museum collection, was presented by Mr W.J. Hooper, who found it in early January 1977, at the northern roadside adjoining Avon Loc. 19 196, 6 km east of the railway line at Muntadgin. A nearby borrow pit may have been the source of gravel used on the road and containing the specimen. The site of find has co-ordinates 118°37'E, 31°46'S.

Muntadgin is approximately 260 km north of east from Perth and is within the western of two recognised belts of occurrence of unusually large australites (Cleverly & Scrymgour, 1978); the largest and heaviest of all known australites was recovered near Notting, only 85 km distant (Cleverly, 1974).

### DESCRIPTION OF AUSTRALITE

The specimen is a core, the remnant shape after loss of frontal glass by ablation stripping during oriented, hypersonic velocity encounter with the

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earth's atmosphere, and subsequent loss by spalling of the aerothermal stress shell. Terrestrial weathering processes have been responsible for losses represented by a variety of shallow sculptural features, but it is uncertain whether terrestrial processes have also been responsible for the major losses from the anterior surface which resulted in its asymmetrical shape (Fig. 1). If those losses were terrestrial, they must have occurred on impact with the earth's surface or shortly afterwards because the scars are as abundantly and deeply etched as other parts of the australite surface. The shape of the specimen is oval in plan view (i.e. when looking down the line of flight) — Fig. 1A. The line of flight is taken to be normal to the plane of the rim which defines the posterior limit of the discarded stress shell. The sense of movement is abundantly demonstrated by such features as the flow swirls characteristic of primary surface (the protected posterior surface during atmospheric flight), and the abundance of grooves of U-shaped cross section characterising surface exposed by loss of the frontal aerothermal stress shell. The elongation, defined as length/width, is 1.23; the shape is therefore broad oval in the definition of Fenner (1940).

The dimensions are 69.9 x 56.9 x 35.2 mm measured in the conventional manner with length and width in directions normal to the line of flight and thickness parallel to it.

The rim is generally sharp and it undulates only very gently. An equatorial zone of average width 12 mm is present along one side of the core between the rim and a rather rounded anterior shoulder (Fig. 1B and 1C); the equatorial zone has been eliminated elsewhere by the major losses responsible for the asymmetry of the anterior surface.

The specimen weighs 167.98 g: only 18 heavier australites have been recorded (Cleverly 1974; Cleverly & Scrymgour, 1978; Scrymgour, 1978). The specific gravity, measured by loss of weight in toluene at 20.3°C, is 2.428; this is a typical value for large australites from south-western Australia, for which the specific gravities of 25 previously reported specimens are in the range 2.420-2.439 and the weighted mean is 2.427 (Cleverly *op. cit.*).

Minor sculpture has been extensively developed on the australite surface by etchants in the soil water, and is of considerable variety. The more notable features are as follows. The posterior surface of flight is dominated by an etched, slightly eccentric, ovoid flow swirl (35 x 28 mm). Between that swirl and the rim, there is a small elongate flow swirl (28 x 6 mm) and portions of two others in an area of complex flow lines. The schlieren defining these flow lines have been etched to the extent that a few of them

are shallow grooves of U-shaped cross section (U-grooves). The short existing length of equatorial zone carries deeply etched 'flake scars', the sites of detachment of the petaloid portion of the stress shell. Short U-grooves are extensively developed on the anterior surface. When present in the vicinity of the rim, U-grooves have their typical orientation approximately at right angles to it.

A puzzling and quite unusual feature of the anterior surface is a relatively smooth and slightly raised, plateau-like area c. 26 x 27 mm, almost completely fringed by short U-grooves (Fig. 1D). This relationship of the grooves to a raised area is like their relationship to posterior surface at a rim, and it suggests that the 'plateau' could be a small undiscarded remnant of the stress shell. A large undescribed australite core from Babakin, W.A. (WAM 13 364) supports this interpretation by illustrating the manner in which a fringe of U-grooves may faithfully outline stress shell (Fig. 2C).

The rare feature of the Muntadgin australite which justifies its individual description, is the form of the transverse posterior profile, which is quite evidently not the arc of a circle but flatly elliptical (Fig. 1C). The specimen is so large that it could be immediately confirmed with a lens measure of 2 cm span that there is increasing curvature in each direction outward from the posterior pole towards the rim.

It is usual to regard oval australites as derivatives of prolate spheroids (which are circular in the transverse section), but such attributions arise from default. The longitudinal posterior profile of many oval australites is quite clearly elliptical, but the transverse profile is shorter, and especially upon small and weathered specimens, its divergence from the arc of a circle is difficult, if not impossible to detect. The simplifying assumption is therefore usually made that the primary body was a prolate spheroid. The shapes of rotating primary masses of melt were determined by an equilibrium between surface tension and centrifugal force, but the centrifugal force acted not only toward the ends of the body but also in the transverse direction, and for that matter, in all other intermediate directions at right angles to the axis of rotation (the vertical axis in Fig. 1B & 1C and Fig. 2B). It must be suspected therefore that the transverse section of most australite primary bodies was never closer than approximately circular, i.e. that the so-called prolate spheroids were in reality triaxial, though the fact can seldom be demonstrated from the weathered remnant of profile available. The Muntadgin australite has an exceptional length of transverse profile (nearly 7 cm) and the posterior surface is less weathered than on

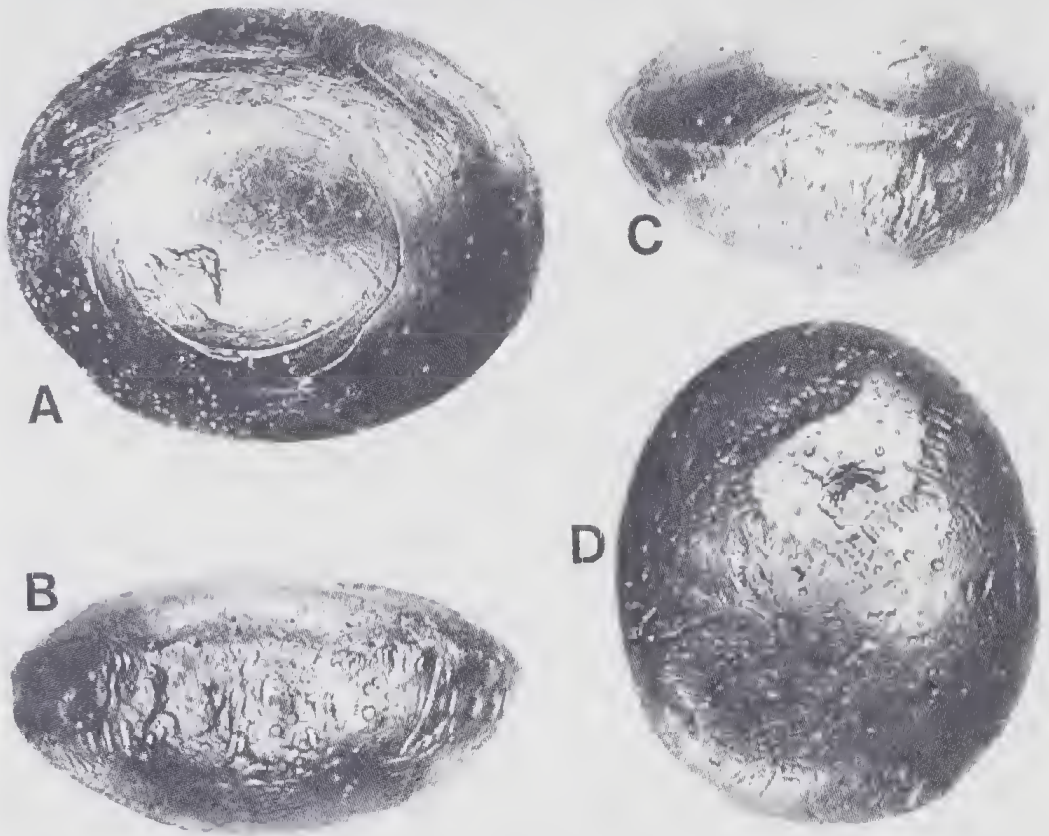


FIG. 1

Broad oval australite core from Muntadgin, W.A. (WAM 13 396)

A: Posterior surface of flight showing large flow swirl defined by etched schlieren and U-grooves, small elongated swirl at upper right and zone of pitting extending around periphery of lower left quadrant. B: Side elevation (upper edge of A) with direction of flight towards bottom of page, showing longitudinal posterior profile, rim, anterior shoulder (left profile only) and part of equatorial zone. Two deeply etched flake scars are visible on the equatorial zone (centre and left of centre) and a few U-grooves are oriented approximately normal to the rim. C: End elevation (right hand end of A) with direction of flight towards bottom of page, showing transverse posterior profile and sharp rim. Anterior shoulder and equatorial zone present only to right side of centre. Portion of the 'plateau' featured in D is visible on the highly asymmetrical anterior surface below at middle of anterior profile. D: Anterior surface viewed somewhat obliquely to line of flight showing the relatively smooth and highly reflecting 'plateau' suspected as remnant of stress shell with surrounding fringe of U-grooves. Upper end of this view is the underside of the right hand end of A. Scales differ slightly but all views are close to natural size.



almost any other large Western Australian australite. This fortunate combination provides a rare opportunity to attempt the reconstruction of a triaxial primary body.

## RECONSTRUCTION OF PRIMARY BODY

The reconstruction of a primary (parental) body is made possible by the existence upon an australite of a portion of the primary surface — the protected posterior surface during oriented atmospheric flight. The quality of the reconstruction is necessarily limited by the extent to which terrestrial destructive processes have affected that surface.

The reconstruction of a primary body which approximated to a prolate spheroid is relatively simple because the radius of curvature of the transverse posterior profile is also the semi-minor axis of the elliptical longitudinal profile. The origin of the axes on a longitudinal section (Fig. 2A) can be located by first describing an arc with the transverse radius of curvature centred upon the mid-point of the profile, and then drawing a tangent to it parallel to the rim; the semi-minor axis, drawn as a perpendicular from the mid-point of the profile, completes the construction. By substituting the co-ordinates of a point on the best preserved part of the profile in the general equation of the ellipse, the length of the semi-major axis and thence the locations of the foci can be calculated, and an ellipse drawn to test its fit to the profile. Some trial and error may be necessary for reasons explained below.

A modified procedure was used for the Muntadgin specimen, taking advantage of two points: first, that the vertical semi-minor axis is common to both longitudinal and transverse elliptical sections; second, that the elongation (length/width) did not change as the result of secondary (aerodynamic) processes including loss of stress shell, provided that the body was ideally oriented in flight. (Stable orientation in hypersonic velocity flight through the atmosphere requires that the aerodynamic centre — the point towards which the total normal pressure vectors on each half of the anterior surface are convergent — should be on the line of flight and posterior to the centre of mass. This could be achieved by a triaxial ellipsoid if the two longer axes were in a plane normal to the line of flight and the shortest axis was in the line of flight.) When an ellipsoid, whether biaxial or triaxial, was affected by aerodynamic losses posterior to the mid-plane, both length and width were reduced, but it may be readily shown from the equations of the circle and ellipse that the length/width ratio was unaffected. A preliminary indication of ideal orientation is that the halves of

each of the longitudinal and transverse posterior profiles are symmetrical about their point of intersection. Reconstruction will subsequently demonstrate whether the vertical axis was indeed the shortest axis or not.

Enlarged longitudinal and transverse profiles of the australite with common mid-point and the rim levels parallel (Fig. 2B) were prepared from readings made with a travelling vernier microscope. The ends of the profiles were extended in what appeared to be natural curves to their points of inflexion at the mid-plane of the body, at the same time observing that elongation, which is here the ratio of the semi-major axis of the longitudinal section to the semi-major axis of the transverse section, should be about 1.23. A trial horizontal axis was then drawn at the average level of the points of inflexion and parallel to rim levels. The common semi-minor axis was drawn as a perpendicular from the mid-point of the profiles to locate the origin of the axes. Proceeding then as for the prolate spheroid, trial ellipses were drawn. The first trials were found to fit the profiles with departure (on true scale) of no more than a fraction of a millimetre at any point except along a length of about 1 cm at one end of each of the profiles where the australite surface is closely and deeply pitted.

It would be expected that a small number of trials with different locations of the horizontal axis or slight angular adjustments of the axis for each profile would usually be necessary to achieve a reasonable fit, but no attempt was made to refine the initial result in this instance. Firstly, because although the posterior surface is fairly well preserved, it is not of a quality which justifies fine distinctions. Secondly, and more importantly, because the true shapes of the primary bodies were not simple ellipsoids but far more complex. They closely parallel the series of shapes shown by minute glass bodies in lunar 'soil'. The general equation for the shapes of those bodies, in which surface tension and centrifugal force are related to viscosity, angular velocity and surface curvature, has been discussed by Bastin & French (1970) and by Fulchignoni *et al.* (1971). For bodies with appropriate degrees of elongation, ellipses can approximate closely to the profiles, and the imperfect weathered surfaces of australites do not encourage the mathematical fitting of more highly complex curves.

The primary body had approximate dimensions 77 x 62½ x 40 mm and volume about 101 cm<sup>3</sup> calculated as a triaxial ellipsoid. Assuming that the primary body had the same specific gravity as the remnant core, its mass was c. 245 grams. Loss of mass (or volume) from the primary body as the result of secondary and terrestrial processes has therefore been 31%, and the thickness has been reduced by 12%.



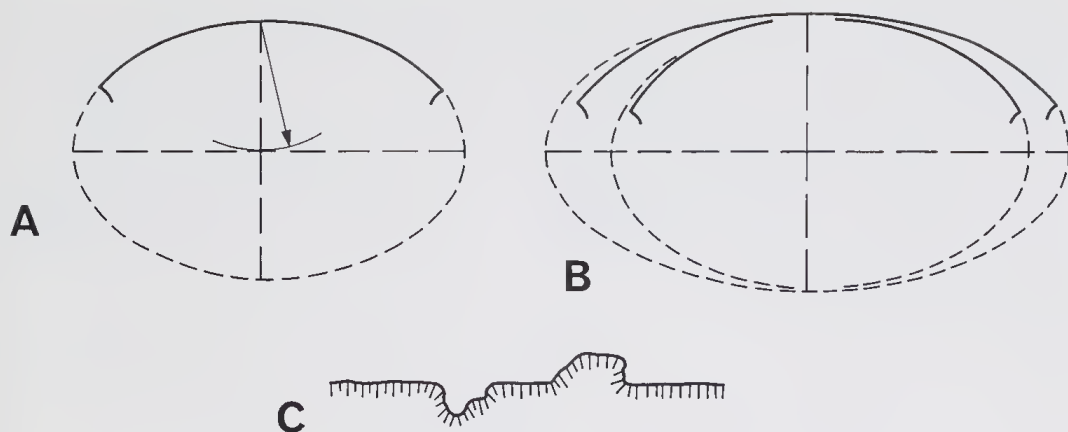


FIG. 2

A: Longitudinal posterior profile of an australite core and notches at rim level (firm line) with reconstruction of longitudinal section of prolate spheroid primary body (for method see text). B: Longitudinal and transverse posterior profiles of australite core from Muntadgin (WAM 13 396) and reconstruction of longitudinal and transverse sections of primary body. The misfit of the ellipses has been somewhat exaggerated. About natural size. C: 'Unrolled' rim of australite WAM 13 364 from Babakin (heavier line) showing tongue of retained stress shell anterior to general level of rim (pointed towards bottom of page) and shallow embayment of detached glass posterior to general level of rim, with fringe of short U-grooves. Semi-diagrammatic.

## DISCUSSION

The loss figures are rather low, even when compared with the primary bodies of 19 other large cores from the same region, which averaged only 46% mass loss and 29% thickness loss (Cleverly, 1974; Table 2). However, when a markedly triaxial body was ideally oriented in flight, it had a larger ratio of frontal area to mass than more closely spherical bodies. It would be more rapidly decelerated and would lose a relatively thin layer of glass as the result of ablation stripping. If the small 'plateau' rising about a millimetre above the general level of the anterior surface is indeed a remnant of stress shell, the shell was likewise unusually thin.

The elongation of the reconstructed primary body is 1.23 as in the australite, but this must be regarded — in spite of the method used — as to some extent fortuitous. For 12 prolate spheroid primary bodies (Cleverly *op. cit.*), the average disagreement between the elongations of the reconstructed primary bodies and of the australites is 4.7%; however, those specimens were generally more weathered than the Muntadgin core.

The primary body of the Muntadgin australite was less massive than the largest representatives of other basic shapes for which I have been able to make estimates with reasonable confidence (Table 1). Larger triaxial bodies certainly existed, as for example the primary body of a 195 g australite core from Narrogin or Naremben (WAM 12 992), but the state of preservation of that specimen precludes calculation as a triaxial body. Opportunities such as that provided by the large and relatively well preserved australite core from Muntadgin rarely arise.

TABLE 1  
Masses and dimensions of large australite primary bodies

Shape	Mass g	Dimensions cm	Reference
Sphere	c. 380	6.7 diam.	Cleverly (1974)
Oblate spheroid	c. 320	7 x 7 x 5.1	Cleverly (1974)
Prolate spheroid	c. 910	10.2 x 8.4 x 8.4	Cleverly (1974)
Triaxial ellipsoid	c. 245	7.7 x 6.2 x 4.0	This paper
Boat primary body	c. 300	9.1 x 4.5 x 4.5	*
Dumbbell primary body	c. 300	10.4 x 4.6(4.0) diam.	*

\* Estimates for boat and dumbbell bodies calculated from data and illustrations of Baker (1969) and Baker (1966) respectively.

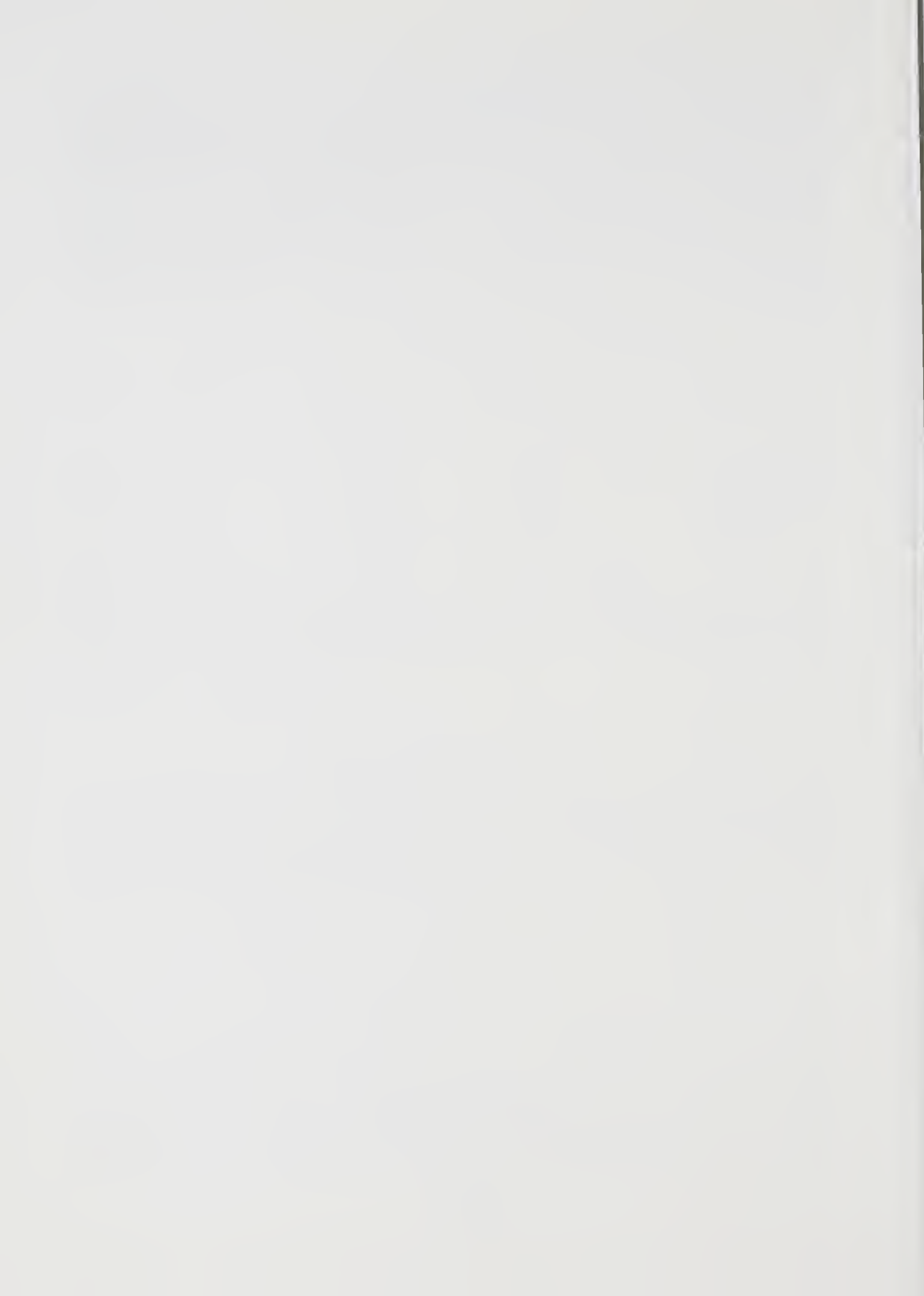
## ACKNOWLEDGEMENTS

I thank the donor of the specimen, Mr W.J. Hooper, for providing careful details of the site and circumstances of find, and I thank also the Board of Trustees of the Western Australian Museum and Dr C. Pearson for making the australite available to me for examination.

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TWO NEW *DIPORIPHORA*  
(LACERTILIA, AGAMIDAE) FROM  
WESTERN AUSTRALIA

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ABSTRACT

*Diporiphora pindan* and *D. valens* are described, and a key is provided for the twelve species and subspecies of *Diporiphora* known from Western Australia.

INTRODUCTION

In my revision of *Diporiphora* (Storr, 1974) I observed that *D. winneckeii* in its typical habitat (desert sand dunes) was a slender lizard with small head and weakly keeled scales. Specimens from clayey or stony soils were more robust, larger headed and less smooth; they were regarded as ecotypic variants of *winneckeii*. Subsequent collections have rendered this treatment invalid, for the Derby variant has proved to be sympatric with true *winneckeii* in the vicinity of the Edgar Ranges, which necessitates its description as a full species. Re-examination of the Tom Price/Kumarina variant has revealed that it is even more distinct from *winneckeii*, and it too is described herein.

Meanwhile Houston (1977) has re-examined much of the material that I identified as *D. winneckeii*. Specimens from western South Australia were allocated to a new species, *D. linga*; the Derby variant was removed from *winneckeii*; and the residue was informally divided into eastern and western races of *winneckeii*, the latter including the Tom Price/Kumarina variant.

The present paper is based solely on material in the Western Australian Museum, except for a specimen in the National Museum of Victoria (NMV). The key includes a taxon not previously recorded from Western Australia, namely *D. bennettii arnhemica*; two specimens (WAM R23061-2) from

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43 km ESE of Halls Creek were overlooked in my revision. I now consider *D. margaretae* a full species; it seems to be closer to *pindan* than to *bilineata*.

Besides mapping the distribution of the new species (Map 1), I have prepared a map (Map 2) for *D. winneckei*; its amended Western Australian range is 'arid zone north to Nita Downs, Edgar Ranges (18°53'S, 123°43'E) and Mt Romilly, and south on the northwest coastal plain to Wandagee and in the Great Victoria Desert to Streich Mound; mainly in spinifex-dominated dunes and sandplains.'

*DIPORIPHORA PINDAN* SP. NOV.

Holotype

R58402 in Western Australian Museum, collected by Mr R.E. Johnstone on 17 April 1977 at 5 km N of Coulomb Point, Western Australia, in 17°18'S, 122°10'E.



Plate 1: Holotype of *Diporiphora pindan*.





Map 1: Map of Western Australia, showing location of specimens of *Diporiphora pindan* (solid circles) and *D. valens* (hollow circles).

## Diagnosis

A small *Diporiphora* with homogeneous dorsals, no gular fold, no post-auricular fold or spine, and very weak scapular fold. Most like *winnecke*i but distinguishable by its more strongly keeled scales (e.g. gulars weakly keeled, rather than smooth), stouter body and limbs, larger head and narrower vertebral stripe.

## Distribution

Arid and semiarid west Kimberley from Dampier Land south to Lagrange and east to Derby and the Edgar Ranges, mainly in pindan (a thicket, mostly of *Acacia* spp., growing on light red soils). Also recorded by Houston (1977) for Joanna Spring in the Eastern Division.

## Description

Snout-vent length (mm): 31-61 (N 57, mean 47.8). Length of appendages (% length of body): head 31-48 (N 55, mean 37.7), foreleg 46-70 (N 55, mean 55.2), hindleg 73-113 (N 52, mean 89.0), tail 238-405 (N 51, mean 312). Width and depth of head (% length of head) respectively 60-80 (N 54, mean 67.4) and 46-65 (N 54, mean 54.6).

Upper labials 11-14 (N 53, mean 12.7), including 0-3 small scales at angle of mouth. Lamellae under fourth toe 19-27 (N 52, mean 22.9). Preanal pores 0-3 on each side.

No nuchal crest. Dorsals, laterals and ventrals moderately strongly keeled; gulars weakly keeled. Keels of laterals orientated upwards and backwards. One or two spines often present at end of white labial streak (not to be confused with post-auricular spines of *D. margaretae*).

Dorsal and lateral ground colour pale to moderately dark reddish brown. Grey vertebral stripe about twice as wide as white or grey dorsolateral stripe. *Ca* 8 blackish brown cross-bands on back and upper lateral zone, broken by pale longitudinal stripes, narrowest at contact with dorso-lateral stripe. White stripe from orbit to top of ear. Lower lateral zone white or grey spotted white. Lips and under surface white, except occasionally for 5-6 grey longitudinal stripes on throat (the outer pairs converging on chin) and less commonly two faint grey longitudinal stripes on venter. Occasional specimens of all ages are completely devoid of pattern.

## Remarks

*D. pindan* is so like *D. winnecke*i (especially the far northwestern population, which likewise has no gular fold) that it is hard to believe that they are more than races of the same species. Yet the two taxa are sympatric

in the vicinity of the Edgar Ranges, *pindan* occupying the pindan country, and *winneckei* the sand dunes.

Houston (1977) was less impressed by these resemblances. He regarded *pindan* as closer to *bilineata* (= *margaretae*) than to *winneckei*.

#### Paratypes

Kimberley Division (W.A.): Martins Well (16°34'S, 122°51'E) (58500, 58514-5); Beagle Bay (46463); 5 km N of Coulomb Point (58403-10, 58461, 58503, 58516); Coulomb Point (40266); 'Dampier Land' (58517); Derby (15185, 20262-4, 20317-29, 26834, 46661, NMV D2111); 26 km ESE of Derby (58605); 24 km SSE of Derby (32167); 130 km E of Broome (36336); Streeters Station, near Broome (116); Injudinah Creek (27638); Lagrange (46216); near Edgar Ranges in 18°21'S, 122°53'E (53797, 54013-4, 54018-22, 54028-31, 54038), in 18°21'S, 123°03'E (53998), and at 37 km SSE of McHugh Bore (54080).

#### *DIPORIPHORA VALENS* SP. NOV.

#### Holotype

R31009 in Western Australian Museum, collected by Messrs C. Tideman and R.S. Robinson *ca* December 1968 near Tom Price, Western Australia, in *ca* 22°45'S, 117°45'E.



Plate 2: Holotype of *Diporiphora valens*.

## Diagnosis

A medium-sized *Diporiphora* with homogeneous dorsals, strong gular and scapular folds and usually some indication of post-auricular fold, ridge or spines. Further distinguishable from *D. winneckei* by its greater size, stouter body and limbs, larger and more strongly keeled scales (e.g. gulars weakly keeled, rather than smooth) and narrower vertebral stripe.

## Distribution

Arid western plateau of Western Australia from the Hamersley Range southeast to Kumarina.

## Description

Snout-vent length (mm): 32-66 (N 9, mean 54.0). Length of appendages (% length of body): head 32-39 (N 9, mean 35.2), foreleg 50-62 (N 9, mean 54.8), hindleg 84-97 (N 8, mean 90.8), tail 284-364 (N 7, mean 325). Width and depth of head (% length of head) respectively 63-72 (N 9, mean 68.1) and 51-59 (N 9, mean 56.6).

Upper labials 11-14 (N 9, mean 12.8), including 1-3 small scales at angle of mouth. Lamellae under fourth toe 21-24 (N 7, mean 22.0). Preanal pores 0-2 on each side.

No nuchal crest. Dorsals, laterals and ventrals large, subequal in size, moderately strongly keeled. Keels on laterals sharply directed upwards and backwards. No white labial streak or spines.

Dorsal and lateral ground colour reddish or greyish brown. Usually grey vertebral stripe present, about twice as wide as white dorsolateral stripe. Usually *ca* 8 blackish brown or dark reddish brown cross-bands on back and upper lateral zone, interrupted by longitudinal stripes, no wider at vertebral stripe than at dorsolateral stripe. Occasionally a white line or stripe from orbit to top of ear. Whitish midlateral stripe from base of tail forward nearly to foreleg. Under surface white, except occasionally for three faint grey longitudinal stripes on venter and throat (outer converging on chin).

## Paratypes

North-west Division (W.A.): Marandoo mine-site (52703); Marandoo town-site (52737-8); 3 km SE of Turee Creek (25135); Kumarina (23970-3).



Map 2: Map of Western Australia, showing location of specimens of *Diporiphora winneckeii*.



# KEY TO WESTERN FORMS OF *DIPORIPHORA*

- 1 Keels of dorsal scales mainly parallel to  
midline ... .. 2  
Keels of dorsal scales sharply converging on  
midline ... .. *D. convergens*
- 2 Scales on back not varying much in size ... .. 3  
Vertebral and paravertebral scales much  
smaller than adjacent dorsals ... .. *D. albilabris*
- 3 Gular fold present ... .. 4  
No gular fold ... .. 9
- 4 No post-auricular fold, ridge or spines ... .. 5  
Post-auricular fold, ridge or spine(s) present ... .. 7
- 5 Gulars smooth; body and limbs very slender ... .. *D. winneckeii*  
Gulars keeled; body and limbs not very  
slender ... .. 6
- 6 A femoral pore present ... .. *D. reginae*  
No femoral pores ... .. *D. valens*
- 7 A femoral pore present ... .. *D. bennettii arnhemica*  
No femoral pores ... .. 8
- 8 Gular fold weak, sometimes broken medially;  
keels of posterior laterals converging on  
dorsals; dark dorsal cross-bands (when present)  
narrow and ill-defined; grey vertebral stripe  
(when present) much wider than dorsolateral  
stripe ... .. *D. bennettii bennettii*  
Gular fold strong; keels of posterior laterals  
parallel to dorsals; dark dorsal cross-bands  
(when present) rectangular, clear-cut and as  
wide as interspaces; grey vertebral stripe  
(when present) not much wider than dorso-  
lateral stripe ... .. *D. lalliae*
- 9 No post-auricular fold, ridge or spines ... .. 10  
Post-auricular fold, ridge or spine(s) present ... .. 12

- 10 Scapular fold present; mainly brownish above  
and white below ... .. 11  
No scapular fold; mainly green above and  
yellow below ... .. *D. superba*
- 11 Gulars smooth; body and limbs very slender ... .. *D. winnecke*  
Gulars keeled; body and limbs not very  
slender ... .. *D. pindan*
- 12 Post-auricular fold long and strong ... .. *D. magna*  
Post-auricular fold short and weak or absent ... .. *D. margaretae*

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# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM

Volume 7, Part 3, 1979



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Cover: Details of setae on the dorsal surface of the idiosoma of a spinturnicid mite (*Spinturnix eptesici*) which lives on bats in the Kimberleys, Western Australia.

ISSN 0312-3162

PARASITES OF WESTERN AUSTRALIA  
VII  
OBSERVATIONS ON QUILL WALL MITES  
(ACARINA: ASTIGMATA)

F.S. Lukoschus\*  
and  
H.A.P.M. Lombert†



[Received 1 February 1978. Accepted 23 February 1978. Published 5 June 1979.]

ABSTRACT

Four species of astigmatic mites have been found in an hitherto unobserved biotope, the wall of the feather quills.

A new subfamily FAINOCOPTINAE within the family LAMINOSIOPTIDAE, Vitzthum, 1931 is erected. The species *Fainocoptes nixonii* gen.nov., sp.nov. from *Geopelia humeralis*, *Calamicoptes meliphagae* gen.nov., spec.nov. from *Philemon citreogularis*, *C. conopophilae* sp.nov. from *Conopophila rufogularis*, and *Streetacarus australis* gen.nov., spec.nov. from *Calyptrorhynchus magnificus* are figured and described.

INTRODUCTION

During the Western Australian Field Programme 1976-1977 of the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth, the first author found four species of astigmatic mites in the quill walls of Australian birds; observations were made on the biology of these mites. They share many characteristics with *Laminosioptes hymenopterus* Jones & Gaud, 1962 which were obtained by washing specimens of the eastern American crow (*Corvus b. brachyrhynchus*), a technique which precludes gathering biological information.

There are some morphological similarities between *L. hymenopterus* and the subcutaneous parasites of galliform birds, *L. cysticola* (Viziola, 1870).

The shape of epimera I and II, the form of chelicerae, the shortened forelegs with partial fusion of femur and genu, short setae in dorsal file and long lateral setae, the presence of sejugal sclerites and in being viviparous indicates the morphological similarity. However, the strongly reduced propodosomal shield with characteristic

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borders, the feeble sclerotization of other dorsal parts, the weak coxal regions, the chaetotaxy of legs and lack of a sclerotized ring around the anus, the morphology of developmental stages and their biology indicate that the two species are not congeners.

European, African and American birds have yielded several species, which will be described soon. They form a group of morphologically and biologically related species and they will be separated at the subfamilial level.

Here we will define a new subfamily and describe the Australian genera and species assigned to this new taxon. All measurements are given in microns. In order to condense the descriptions and to give collecting dates for species to be described, many measurements are given in a tabulated form and are not repeated in the formal descriptions.

#### Family LAMINOSIOPTIDAE Vitzthum, 1931

Diagnosis: Small to medium sized astigmatic mites of elongated, dorsoventrally-flattened shape. Vertical setae absent, lateral setae of body remarkably long, dorsal setae very short. Cuticle of the sclerites is smooth, conjuntiva striated. Gnathosoma with short, broad palps and the chelicerae with reduced fixed digits.

Legs I and II short and broad with partial dorsal fusion of femur and genu. All tarsi with dorsal hooks and long stalked disc-like ambulacra. Epimera I Y-shaped with bifid termination, epimera II free with terminations essentially parallel, III and IV free. Sejugal sclerites often present. Female genital region with two valves in inverted V-shape between legs III or IV, and a third transverse valve, small epigynum without connection to epimera, small genital apodemes and no genital discs. Genital region in the males located behind coxal region IV. Adanal or tarsal discs in males absent. Without pronounced sexual dimorphism. Males with shorter opisthosoma, solenidia of the legs may be longer and stronger. Developmental stages with reduced setation. Species of the family are viviparous parasites of the internal feather walls of subcutaneous tissues of birds.

#### Subfamily LAMINOSIOPTINAE Vitzthum, 1931

Small mites (200-260 $\mu$ ) with characteristics of family as mentioned above. Large propodosomal, metapodosomal and opisthosomal shields separated by small regions of striated cuticle. Scapular setae on a propodosomal shield which has no strongly marked borders. The short triangular gnathosoma is broadly fused to the idiosoma, not extending legs I. The legs are inserted ventrally. All setae of legs are short and spinelike, the ambulacra of tarsi elongated, each with four small lobes. All coxal fields distinctly sclerotized. The female genital opening between legs III. Genital setae near the genital valves are lacking. A distinct ventral anal shield with strongly sclerotized ring around the anal split. Males with a short opisthosoma, the

genital region touching coxal fields IV. The solenidia of legs I and II are longer and stronger than in the female. The developmental stages have well formed legs III and IV and strongly sclerotized epimera.

Parasites of the subcutaneous tissues of birds.

Type genus: *Laminosioptes* Mègnin, 1880.

#### Subfamily FAINOCOPTINAE, new subfamily

We dedicate the typical genus to our colleague A. Fain, Antwerp. (koptein = to burrow, as to biology of these mites)

Medium sized mites with the characteristics of the family. The small propodosomal shield covers only the median part between the scapular setae, with characteristic *Knemidokoptes*-like sclerotized borders. Parts of the metapodosoma and opisthosoma may have feeble incrustated smooth regions without distinct borders to broad striated regions of body. The gnathosoma is broadest apically, the connection to the idiosoma appears neck-like. Gnathosomal wings may or may not be present, but the structure that may form these wings is always present. The segments of legs I and II of equal length; legs III and IV with femora and genua about half the lengths of the remaining segment. The ambulacra appear as rounded empodial discs, in which a triangular central plate may be present. The coxal fields lack sclerotization. The female genital opening lies between epimera IV with 1-2 genital setae near valvae. The anal opening is terminal, lacking anal shield and sclerotized ring. Males with the genital region separated from coxal fields IV on the opisthosoma; the opisthosoma shorter than in females. The solenidia of hind legs are longer than in females. Developmental stages with poorly formed hind legs and without visible epimerae.

Parasites of developing feathers.

Type genus: *Fainocoptes* gen.nov.

#### *Fainocoptes* gen.nov.

Legs III and IV long and slender. All setae of the idiosoma and legs are seti- to filiform. Lateral winglike protrusions are present behind legs II. Lateral flaps on gnathosoma are absent. Lateral sclerites (sejugal sclerites) between laterals 1 and the humerals are absent or only poorly sclerotized.

Chaetotaxy of idiosoma: present are *sc i*, *sc e*, dorsals I-5, laterals 1-5, 1-2 pairs of genitals, *h*, *sh*, *cx I*, *cx III*, *cx IV* and one pair of anals.

Chaetotaxy of legs: tarsi 6-7-4-5, tibiae I-I-1-I, genua 2-2-0-0, femora I-I-0-0, trochanters 1-I-I-I.

Solenidiotaxy: tarsi 2-1-0-0, tibiae I-I-I-1, genua I-I-I-0.

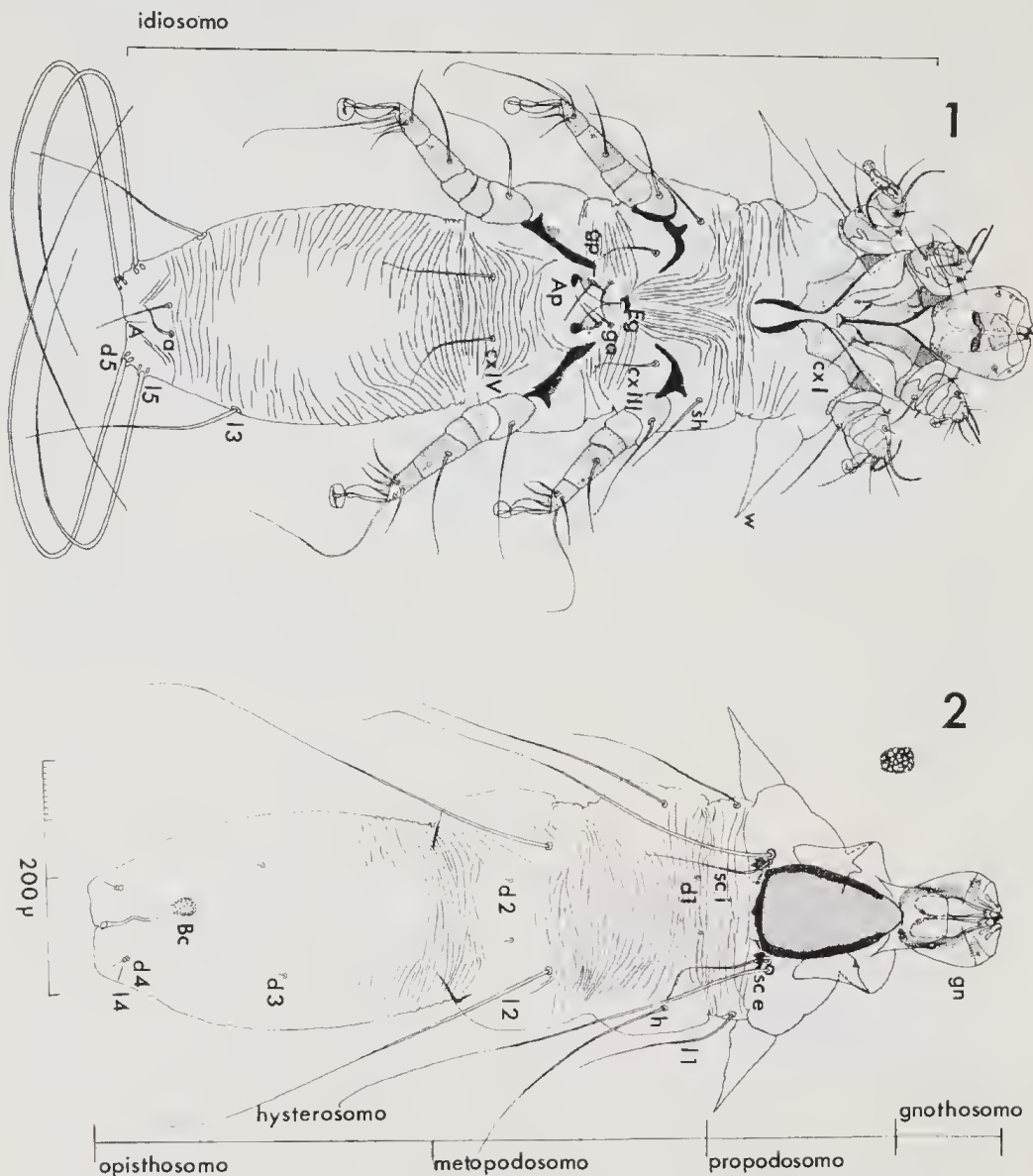
Type species: *Fainocoptes nixoni* spec.nov.

*Fainocoptes nixonii* spec.nov.

We dedicate the species to Mr John Nixon, Beverley Springs Station, who with his family, has given much help and facilities to the base camp.

Elongate species of pale yellow colour with brown legs and a prodorsal shield.

**Female (holotype) (Figs 1-6):** Length including gnathosoma 770, average of 10 paratypes 782 (756-799), width 195, in paratypes 216 (189-237).



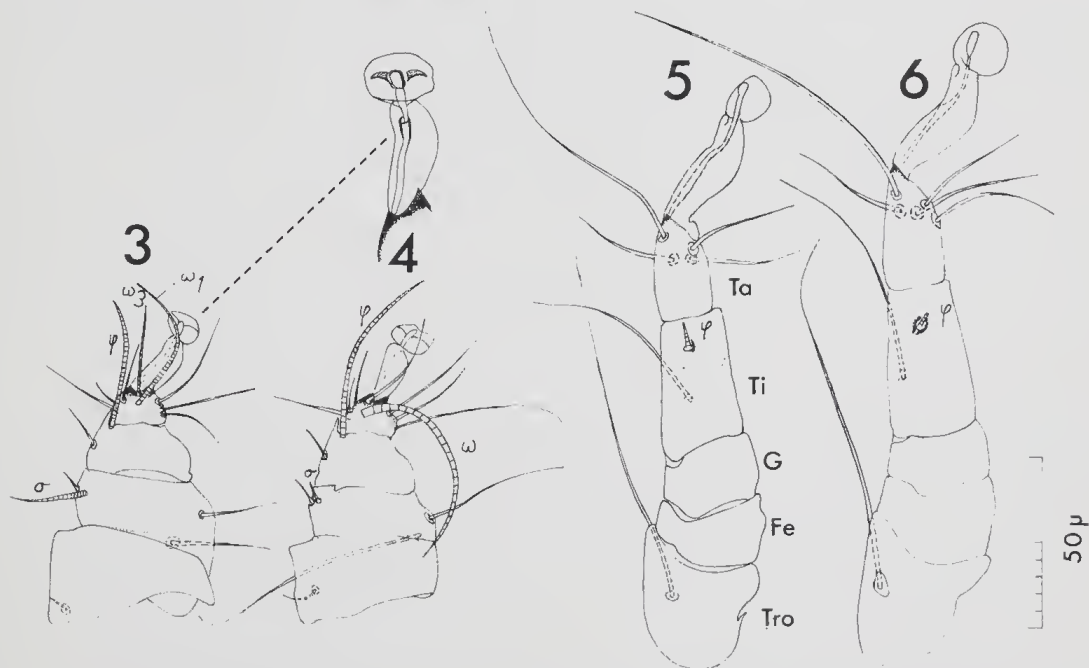
Figs 1,2: *Fainocoptes nixonii* spec.nov. Holotype female. 1 - ventral view, 2 - dorsal view.



**Venter (Fig. 1):** Idiosoma with characteristic striation, as figured. Insertion of legs in two widely separated groups. All legs inserted laterally. Genital region lies between epimera IV. Genital opening in the form of an inverted V with three valves. Small epigynum (Eg) in front of the genital valves; genital apodemes (Ap) are present. No connections of genital sclerites to epimera III or IV. Two pairs of genital setae (*g a* and *g p*) present near valves. Anus (A) terminal, without sclerotized ring. One pair of anal setae (*a*) present on venter. Further idiosomal setae: coxal setae in fields I, III and IV (*cx I*, *cx III* and *cx IV*) and subhumeral setae (*sh*). Lateral setae 3 + 5 and dorsals 5 shifted to lateral sides of venter, not inserted on protruding tubercles.

**Dorsum (Fig. 2):** Propodosomal shield with strongly sclerotized borders and U-shaped. Scapular setae on edges of the shield. Cuticle in the region of dorsals 2 and on the middle of opisthosoma without striation and slightly incrustated. There are definite changes of striated to somewhat incrustated regions of cuticle without distinct borders. Bursa copulatrix (Bc) ending dorsoterminally. Dorsal setae 4 and laterals 4 are very close.

**Legs (Figs 3-6):** with five free segments and long stalked pretarsus, with the exception of segments femur and genu of legs I and II, which are partially fused dorsally. Legs I and II notably shorter and broader than the hind legs. Tarsi of the forelegs with two, hind legs with one, strongly sclerotized hook. Pretarsi in the form of long empodial discs with condylophore and without empodial claw. Pretarsi on forelegs are smaller and shorter than on the hind legs.



**Figs 3-6:** *Fainocoptes nixonii* spec.nov. Holotype female, legs in dorsal view. 3 - leg I, 4 - leg II, 5 - leg III, 6 - leg IV.

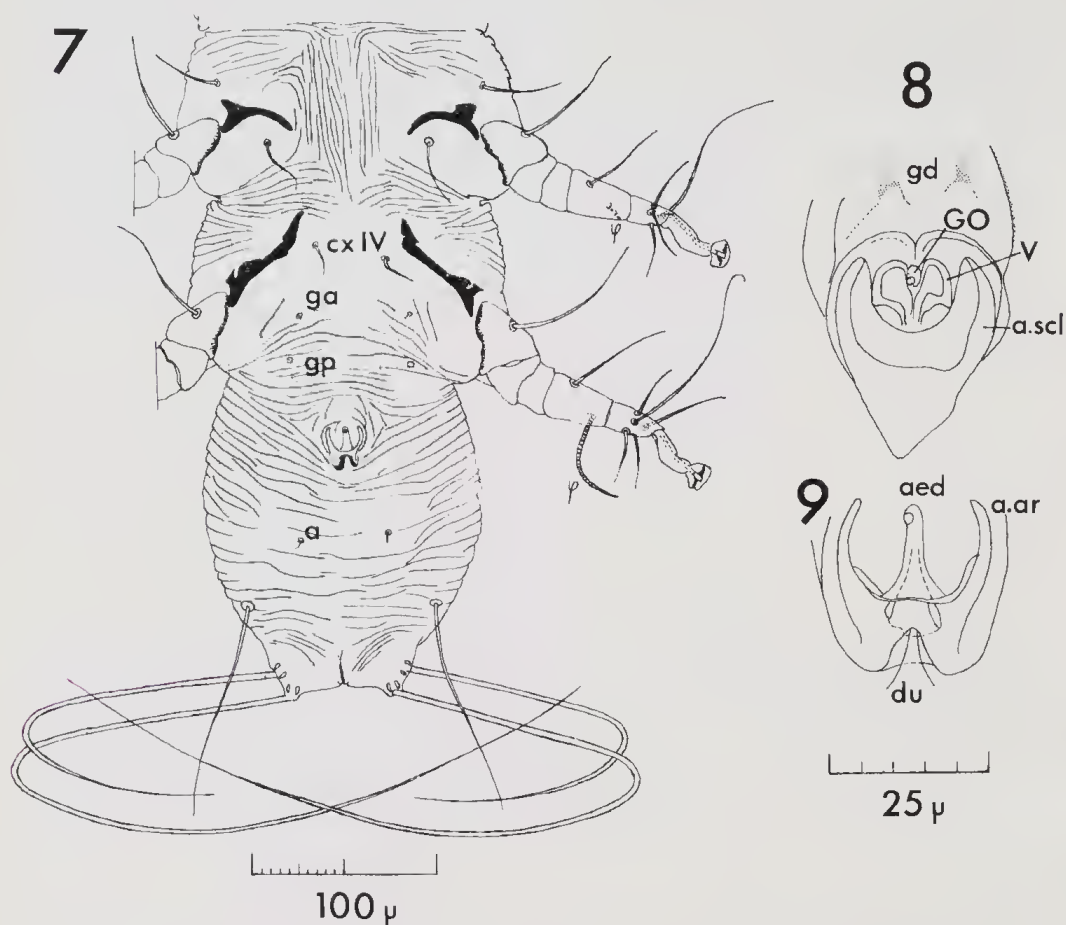


Chaetotaxy and solenidiotaxy as in the definition of genus.

Measurements in **Tables I and II.**

Gnathosoma head-like, articulated with smaller 'neck' to idiosoma, with short two-segmented palps and scraping chelicerae without fixed digit. Gnathosoma distinctly surpassing tarsi I in length. Four pairs of setae are present on the gnathosoma: two on palp tibia, the dorsal one closer to the idiosoma than the ventral one, and two setae and one solenidion on the palp tarsus, the setae more or less inserted laterally near the base of the tarsus. Two additional pairs of setae may be present on the tarsus between the two anterior sclerotized edges behind the solenidion.

**Male** (allotype) (**Figs 7-9**): Length 596, width 194; 5 male paratypes with average length of 585 (564-602), average width 200 (185-213).



**Figs 7-9:** *Fainocoptes nixonii* spec.nov. Allotype male. 7 - venter of hind region, 8 - surface view of genital region, 9 - internal view of genital region.

Like females with only differences in measurements, which are given in **Tables I and II**. Genital region distinctly behind legs IV (**Fig. 7**). Long setae near epimera IV are coxal setae IV. The genital region is shifted backwards to the opisthosoma, while genital setae remain constant in positions. Solenidia *phi* on tibiae IV are much longer than in the female. Surface of genital region is shown in **Fig. 8**. Small genital opening (GO) surrounded by genital valves (V) and aedeagal sclerites (a scl). Genital discs, adanal discs and modifications of legs are absent. In front of the copulatory apparatus are two chitinized gland ducts (gd) which open into genital chamber. **Fig. 9** shows a more internal view with an aedeagal duct (du), a short curved aedeagus (aed) with aedeagal articulations (a ar) connected with aedeagal sclerites of the surface.

**Tritonymph (Figs 10-16):** elongated, dorsoventrally flattened, with soft cuticle and with transverse striae on part of dorsum. Legs inserted laterally. Legs I and II with epimera as figured, III and IV without visible epimera. Large winglike projections on dorsolateral surface, contrary to adults, where they are lateral. Opisthosoma tapering to a bilobed end (**Fig. 11**), with anus between the lobes. Propodosomal shield without strong lateral borders but with lateral encavements (**Fig. 12**).

Idiosomal setae *sc i*, *sc e*, *l 1-3*, *l 5*, *h*, *sh*, *d 2*, *d 3* and *d 5* present, speculiform or represented by vestigial setal rings. Functional parts of the gnathosoma as in adults. Legs I and II (**Figs 13 + 14**) of similar shape, though smaller than in adults; III and IV (**Figs 15 + 16**) strongly reduced, probably with unimportant locomotary function.

All tarsi with short pretarsi (Pta), having two hooks each and a small ambulacrum. Setae of the legs short, thin, speculiform or so indistinct that signatures can not be assigned with certainty. Unusual are two solenidia on tarsus II in all observed tritonymphs (also observed in related species, with one exception).

**Protonymph:** like tritonymph with shorter winglike projections, similarly shaped dorsal shield and more reduced setation. Idiosomal setae have not been observed. Tarsi of legs I and II with only one solenidion each.

**Larva:** with three pairs of legs, a short rounded caudal end, with only short winglike projections and somewhat smaller dorsal shield. Solenidia present on tarsi and tibiae I and II. Measurements shown in **Tables I and II**.

**Viviparity:** In females, well chitinized larvae are found in the metapodosoma and opisthosoma always with gnathosomata directed caudally. No eggshells or remnants have been observed. There seems to be almost simultaneous reproduction at a low rate. In a total of 18 females we found:

- 4 ♀ ♀ enclosed or near tritonymphal skin
- 5 ♀ ♀ without enclosed larvae
- 2 ♀ ♀ with 1 enclosed larvae

- 1 ♀ with 2 enclosed larvae
- 1 ♀ with 4 enclosed larvae
- 5 ♀ ♀ with 5 enclosed larvae.

**Biology:** Mites burrow in the outer layer of the quill wall during development. They cause furrows in the surface of the quills, mostly in the part beneath the vane, feeding during development of the feathers in the region of the unkeratinized portion above the feather germ. Mites burrow mostly in the direction of the germ either in a straight line or spiral-like and most of them with the speed of the growing feather. They remain in the region where the cells of the outer layer show first signs of keratization. Mites with deficiencies in movement, i.e. during moulting shift away from the growing feather to regions of keratization, which they can not pass. They become situated in hard cornified layers, and are captured between the quill and the feather sheath. Mites found in fully developed feathers are always enclosed between quill and feather sheath, while many feathers are found with only the mite-caused furrows up to base on the outside of the quill without pathological attachment of the sheath to the quill. Living mites have been found in very young feathers at the base of the blue germ. Intervals between the moults of the host are survived in a somewhat inactive stage in the skin near the papilla. Histological observations on the biology of a species assigned to another genus will be published elsewhere.

#### Host and locality

*Geopelia humeralis*, Columbidae, Columbiformes. Beagle Bay, 25-VIII-1976, Lukoschus leg. Mites were found on quills of the primaries.

**Deposition of types:** Holotype and allotype in Western Australian Museum, Perth. Paratypes in Field Museum of Natural History, Chicago; U.S. National Museum of Natural History, Washington; the Acarology Laboratory, Columbus, Ohio; Queensland Institute of Medical Research, Herston, Brisbane; Institute of Parasitology, Prague; Institute of Tropical Medécine, Antwerp; Department of Zoology, Catholic University, Nijmegen.

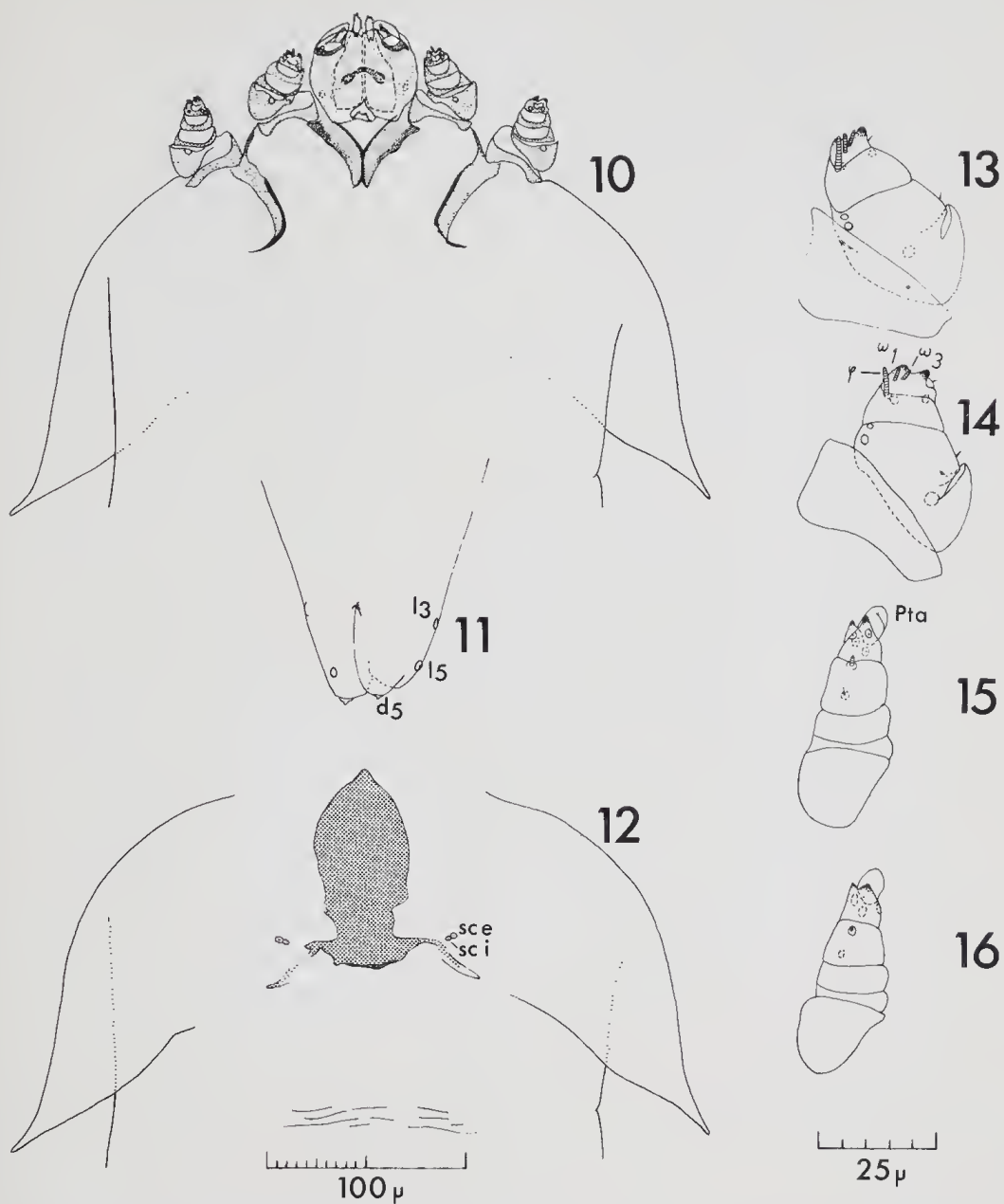
#### *Calamicoptes* gen.nov.

(Calamus = part of feather, situated within the skin.) Legs III and IV slender. All setae of idiosoma and legs seti- to filiform. Winglike projections present on gnathosoma and propodosoma. Sejugal sclerites present between laterals 1 and humerals. Often pores are present behind humerals. Chaetotaxy of legs as in *Fainocoptes*.

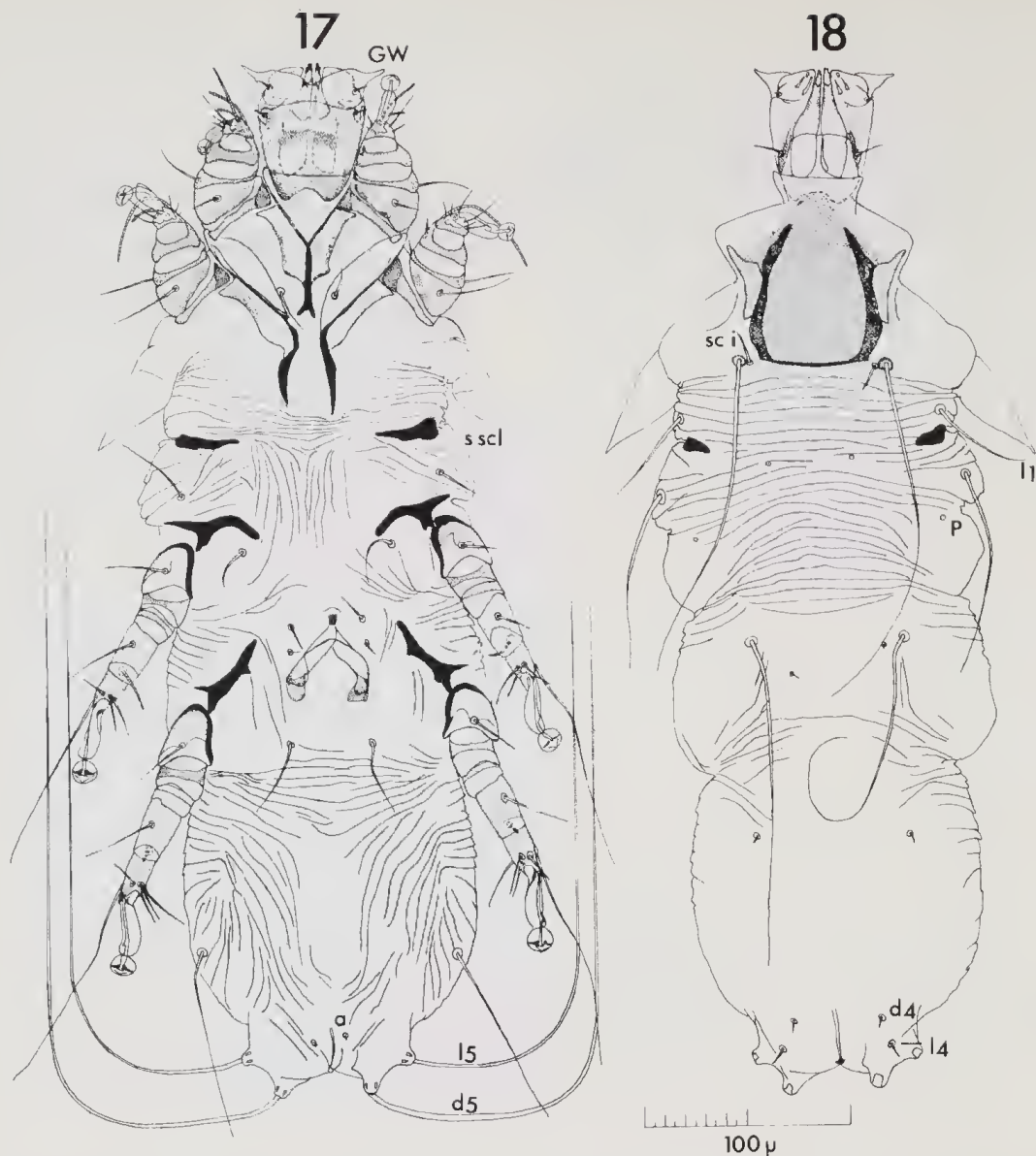
*Solenidiotaxy:* tarsi 2-1-0-0, tibiae 1-1-1-1, genua 1-1-0-0.

*Chaetotaxy of idiosoma* as in *Fainocoptes*.

Type species: *Calamicoptes meliphagae* spec. nov.



**Figs 10-16:** *Fainocoptes nixonii* spec.nov. Tritonymph. 10 - ventral view of anterior part, 11 - caudal end in ventral view, 12 - propodosoma in dorsal view, 13 - leg I, 14 - leg II, 15 - leg III, 16 - leg IV.



Figs 17,18: *Calamicoptes meliphagae* spec.nov. Holotype female. 17 - ventral view, 18 - dorsal view.

*Calamicoptes meliphagae* spec.nov.

**Female:** (holotype) (Figs 17-22): Length 495, 6 paratypes averaged 513 (485-532), width 164, in paratypes 171 (162-176).

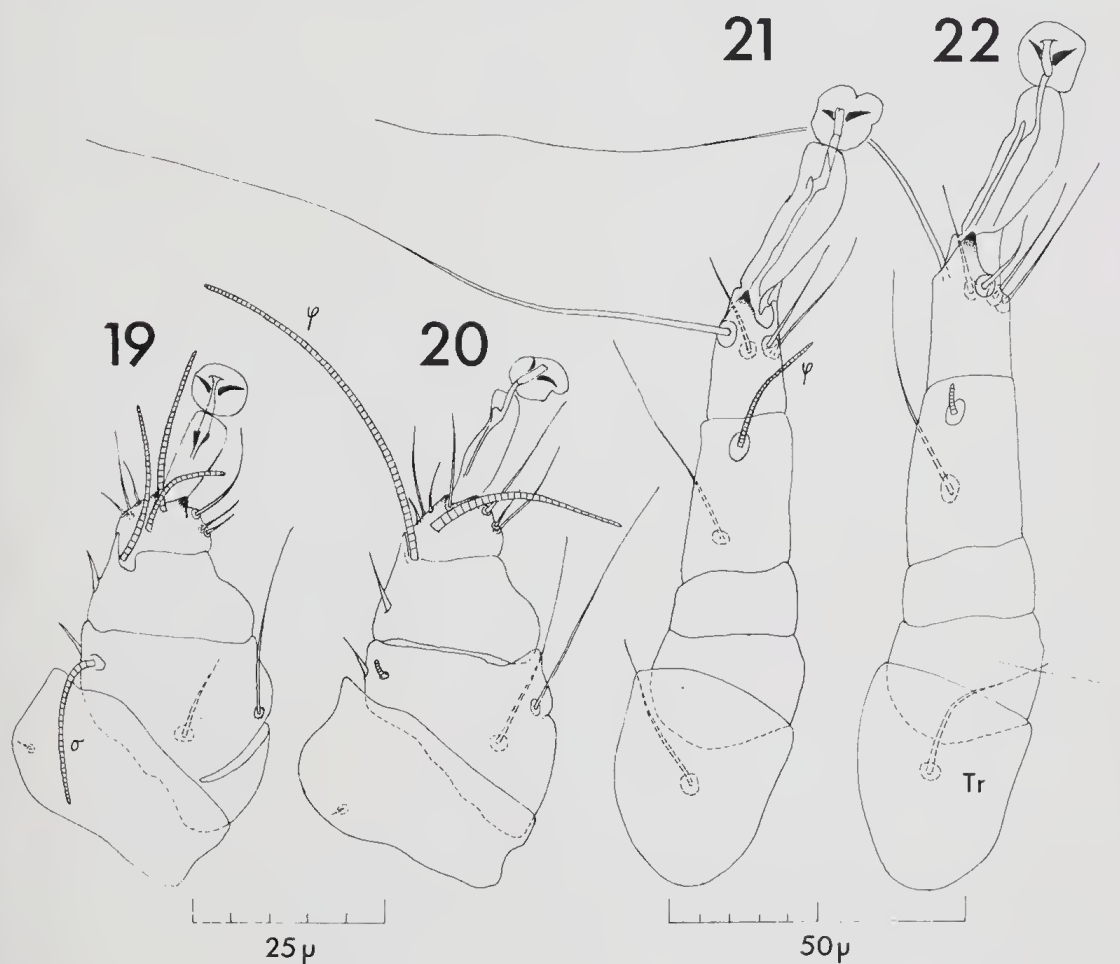
**Venter (Fig. 17):** Many characteristics as in previous species with somewhat different measurements, shown in Tables I and II. Strongly sclerotized band surrounding lateral sides on a line between pro- and metapodosoma. Laterals I belonging mor-



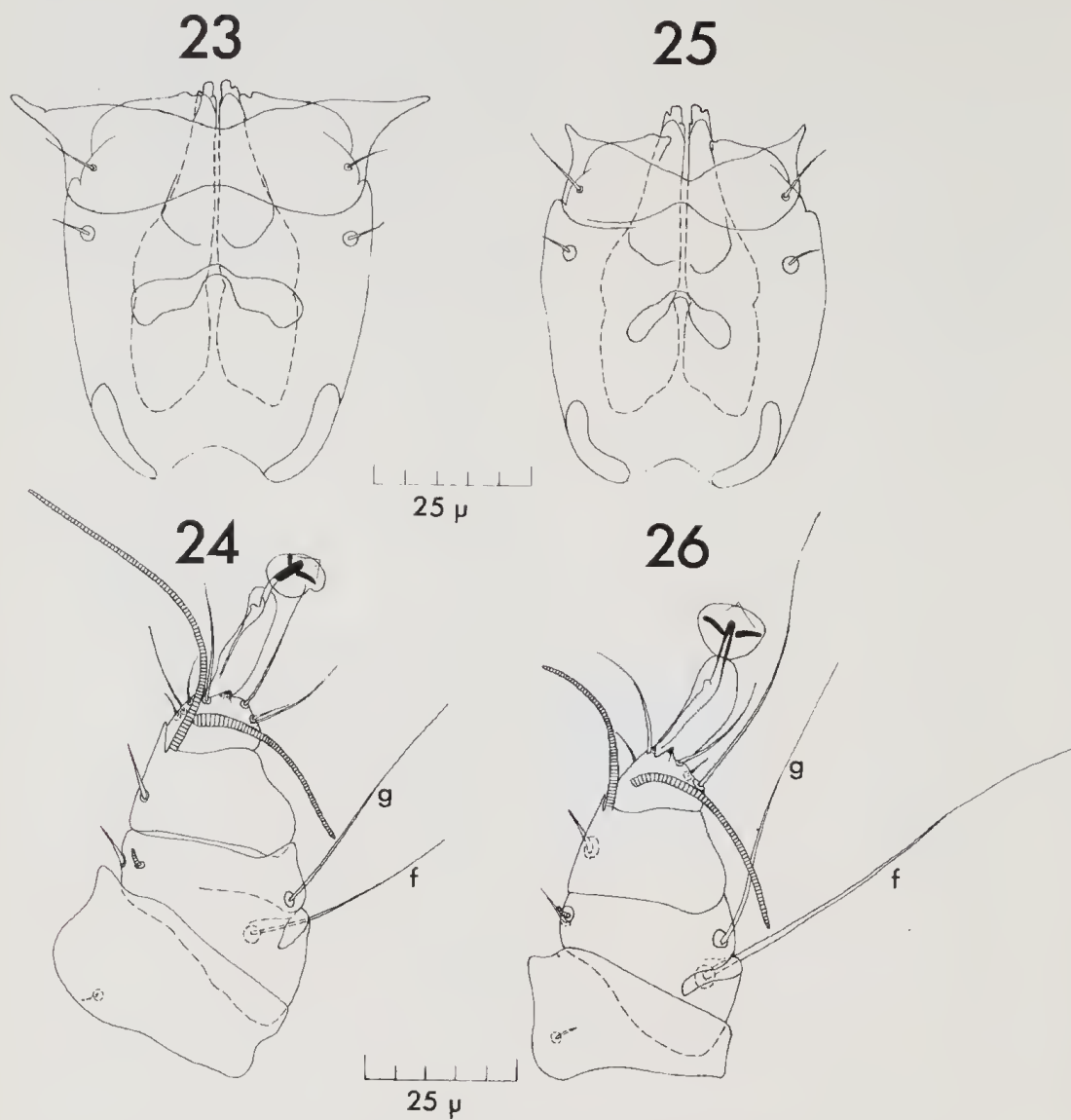
phologically to metapodosoma however are positioned anterior to these sclerites; freshly mounted specimens show them to be placed for attachment of muscle fibres; sclerotizations on this place have not been recorded from astigmatic mites; the term sejugal sclerites (s scl) is proposed. Behind the humerals are small ringlike pores (P). Gnathosoma with winglike projections (gnathosomal wings GW) and longer setae; anterior margins of gnathosomal alae in slight median curve. Caudal end of the opisthosoma slightly bilobed with *d* 5 and *l* 5 on short tubercles. Anal setae very short.

**Dorsum (Fig. 18):** Remarkably different from previous species are the short length of *sc* i, *l* 1, *l* 2; the distance between dorsals 4 and laterals 4, and the shape of the opisthosoma. Measurements shown in **Tables I** and **II**.

Male: and developmental stages have not been collected.



**Figs 19-22:** *Calamicoptes meliphagae* spec.nov. Legs in dorsal view. 19 - leg I, 20 - leg II, 21 - leg III, 22 - leg IV.



Figs 23-26: Comparison of *Calamicoptes* species. 23 - *C. meliphagae*, gnathosoma in ventral view. 24 - *C. meliphagae*, leg II in dorsal view. 25 - *C. conopophilae* spec.nov. gnathosoma in ventral view. 26 - *C. conopophile* spec.nov. leg II in dorsal view.

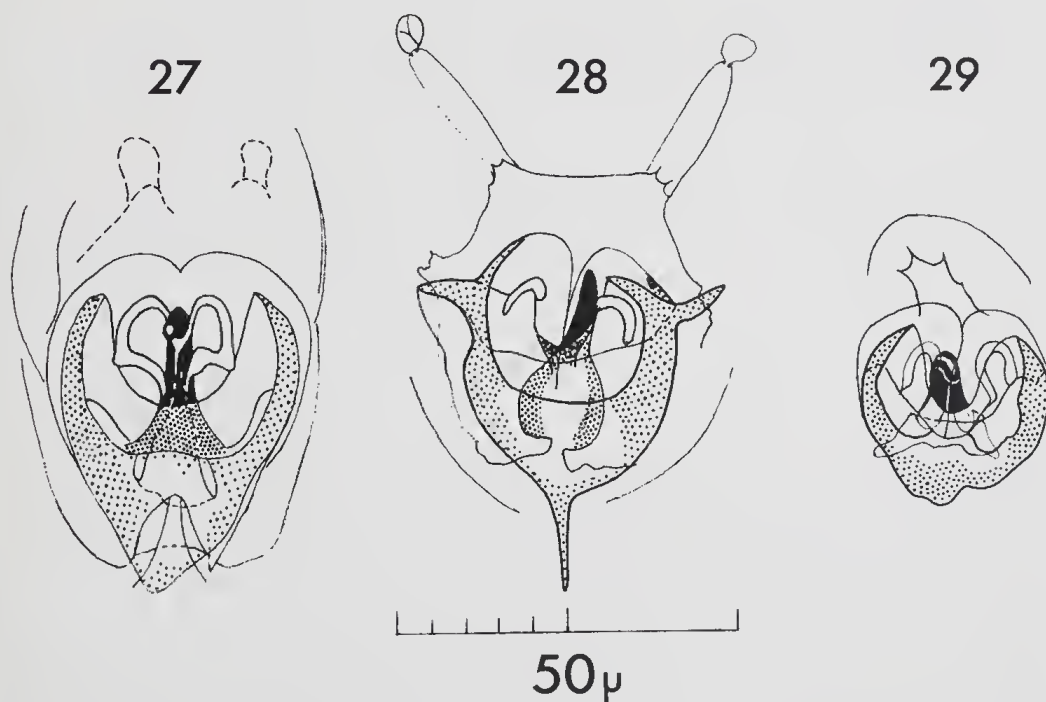
**Host and locality:** *Philemon citreogularis*, Meliphagidae, Passeriformes, 26-VIII-1976, Beagle Bay, Lukoschus leg.

**Deposition of types:** Holotype in Western Australian Museum, Perth. Paratypes (6) in Chicago, Washington, Antwerp and Nijmegen.

*Calamicoptes conopophilae* spec.nov.

Closely related to *C. meliphagae*. The species parasitizes related hosts of the family Meliphagidae.

**Female** (holotype): Length 442, width 147. Main characteristics: presence of sejugal sclerites, pores behind humerals, winglike lateral projections on propodosoma and gnathosoma; anterior margins of the lobes on the gnathosoma form strong curve. Distance between *d* 4 and *l* 4 similar to previous species. Differences surpassing the range of variability are the length of solenidia and setae of legs, of the genital and anal setae, the length and width of gnathosoma and the lateral projections on propodosoma and gnathosoma. In Figs 23-26 gnathosoma and legs II of both species are compared.



Figs 27-29: Male genital regions of 27 - *Fainocoptes nixonii*, 28 - *Streetacarus australis* and 29 - *Calamicoptes conopophilae*.

**Male** (allotype): Length 245, width 139. Main characteristics are sejugal sclerites, lateral winglike projections on the gnathosoma and propodosoma, pores behind humerals as in female. Distinctly different are the measurements of the opisthosoma, genital setae and *phi IV*. Male genital region located on posterior half of opisthosoma. Details of genital apparatus (**Fig. 29**) similar to *F. nixoni*.

**Tritonymphs**: without lateral wings, but with rounded caudal end and with longer solenidia on legs I and II. Other characteristics as in *F. nixoni*.

**Host and locality**: *Conopophila rufogularis*, Meliphagidae, Passeriformes, Brook-  
ing Springs, 1-X-1976, Lukoschus leg. Mites have been found in quills of the  
primaries.

**Deposition of types**: Holotype in Perth, paratypes in Chicago and Nijmegen.

*Streetacarus* gen.nov.

Legs III and IV slender. All setae of idiosoma and legs are seti- to filiform. Without winglike lateral projections on gnathosoma and propodosoma. Sejugal sclerites present. Chaetotaxy of idiosoma and legs and solenidiotaxy as in *Fainocoptes*.

Type species: *Streetacarus australis* spec.nov.

We dedicate the genus to the sponsor of the expedition, Mr William S. Street.

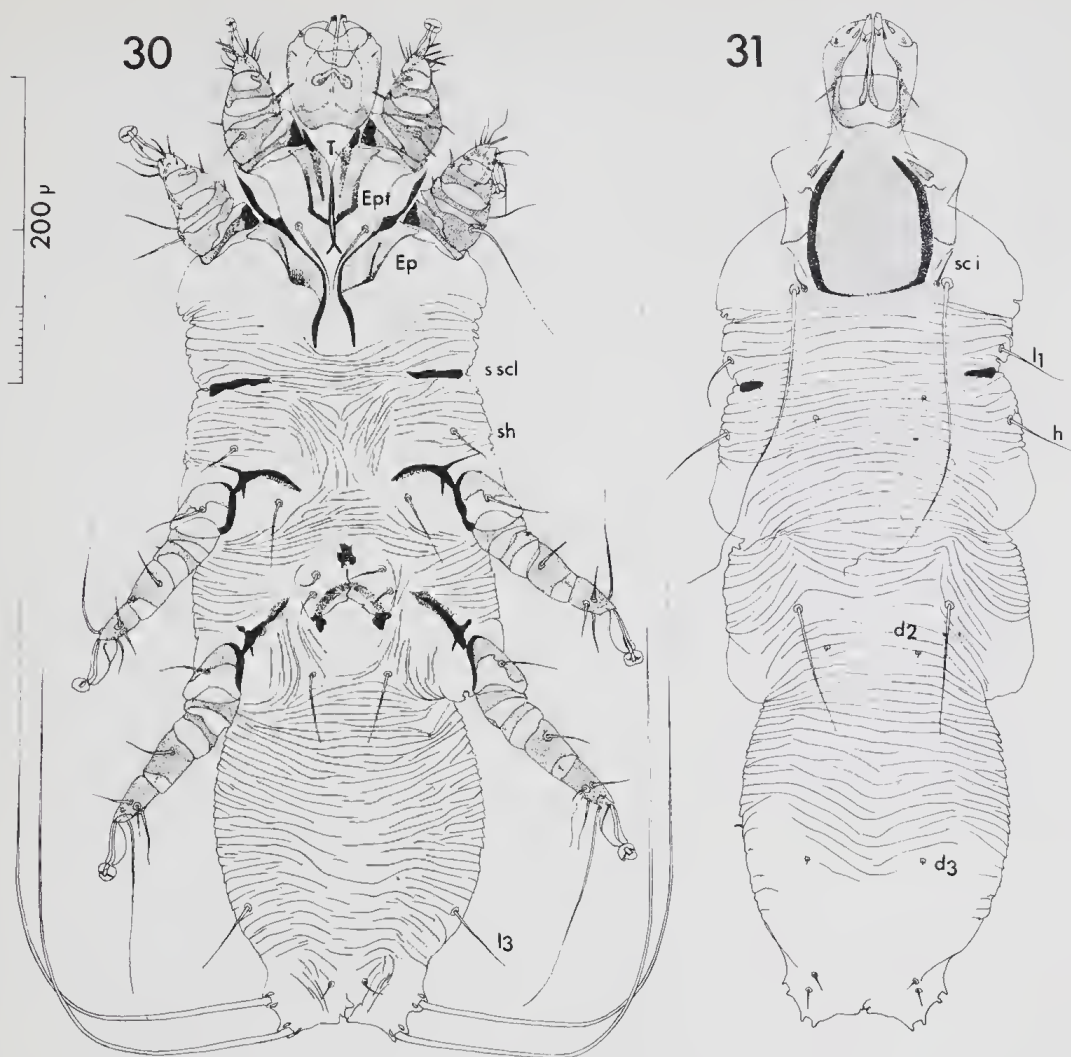
*Streetacarus australis* spec.nov.

Medium sized mites of pale yellow colour and brown legs.

**Female** (holotype) (**Figs 30-35**): Length 655, 10 paratypes measured 698 (661-722), width 221, in paratypes 217 (205-228).

**Venter** (**Fig. 30**): Striation of idiosoma is as figured. Legs inserted laterally, the coxal fields without sclerotization. In coxal fields I epimerites (Ept) are present, running to epimera II (Ep). Sejugal sclerites are lacing lateral sides of body between laterals 1 and humerals. Setae *sh* and *l 3* are relatively short. Genital region located between epimera IV, with broad valves, epigynum and genital apodemes. Setae *g a* and *g p* on valves, *cx IV* far behind *g p*. Gnathosoma without winglike projections, 'headlike', articulated to the idiosoma. Distinct tendons (T) on dorsal and ventral sides act for movement.

**Dorsum** (**Fig. 31**): Transverse striations on most parts, a smooth, poorly sclerotized cuticle restricted to the region between dorsals 3 and 4. Setae *sc i*, *l 1* and *l 2*, *h* relatively short. Bursa copulatrix dorsoterminal on short tubercle. Legs (**Figs 32-35**) in shape and setation as in *Fainocoptes*. (Presence of solenidion on genu III indicates a more primitive condition.)



30,31: *Streetacarus australis* spec.nov. Holotype female. 30 - in ventral view, 31 - in dorsal view.

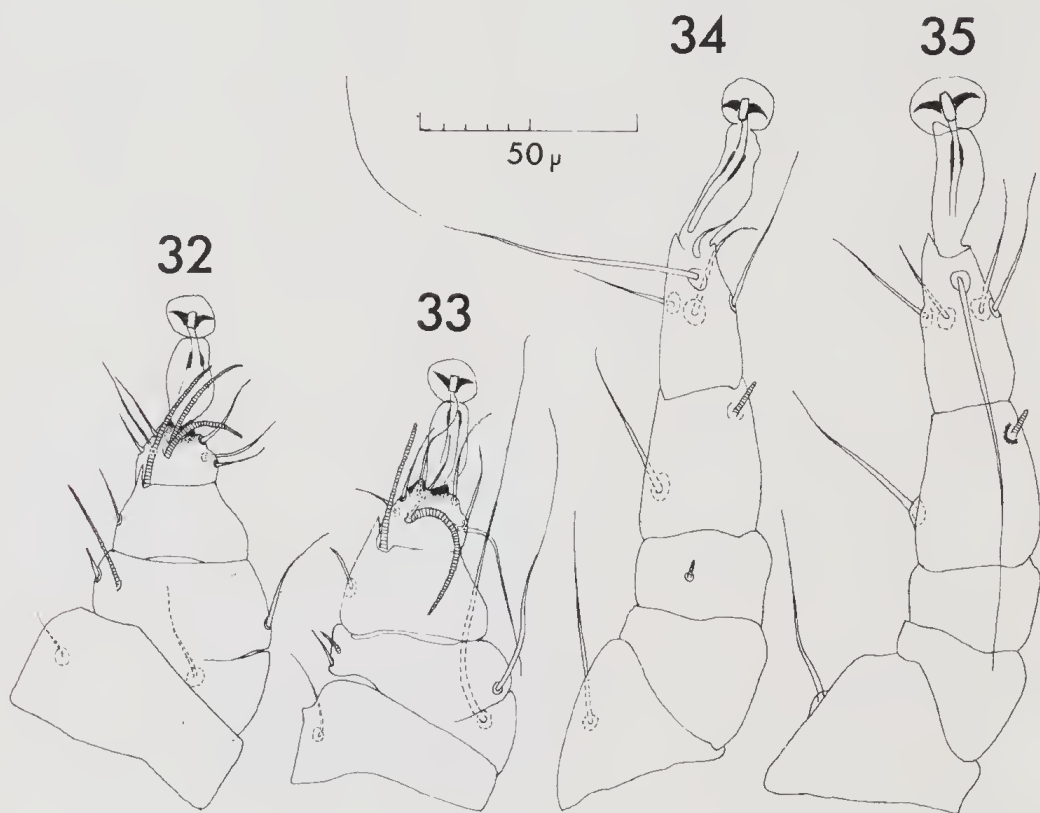
**Male** (allotype): Length 638, 3 paratypes average 600 (597-606); width 237, paratypes average 223 (218-228). Without remarkable sexual dimorphism. Striation ventrally as in female; dorsally the smooth cuticle extends also to the front of dorsals 3. In legs IV the apical setae thin and short (9 contrasted to 130 in female) and solenidion *phi* of leg IV is  $20\mu$  (in female 6). Genital region located in the middle of the opisthosoma. Genital apparatus (Fig. 28) with distinct genital atrium and long chitinized parts of accessory gland ducts.

**Tritonymph**: elongated, dorsoventrally flattened; dirty white in colour.

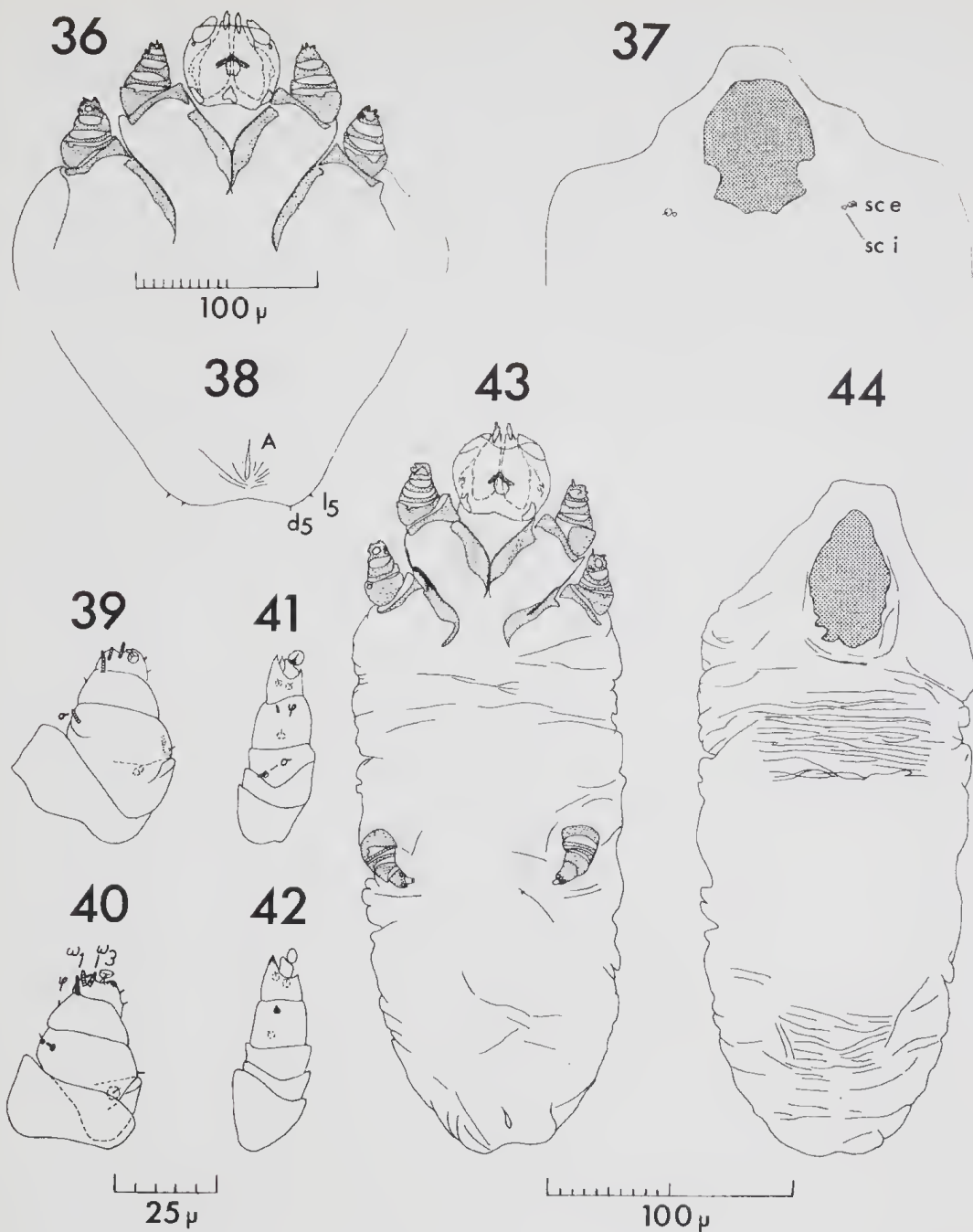


**Venter (Figs 36 + 38):** All legs inserted laterally, epimera I in short Y-shape almost similar to adults, II short without parallel terminations, III and IV absent. Gnathosoma shorter and rounder than in adults. Anal split (A) subterminal. Caudal end blunt.

**Dorsum (Fig. 37):** with weakly sclerotized propodosomal shield without pronounced borders running to scapular setae. Shield symmetrical with laterocaudal incisions. Cuticle very soft with transverse striations in median parts. Setation of idiosoma reduced. Observed have been only peglike *sc i*, *sc e*, and laterals 5 and dorsals 5. All legs (Figs 39-42) short with segments as in adults. Pretarsi with short stalked small, round ambulacral discs. Sclerotized hooks on tarsi less pronounced than in adults. Chaetotaxy: tarsi 4-7-2-2, tibiae 1-1-1-I, genua 1-2-0-0, femora I-1-0-0, trochanters 0-0-0-0. Solenidiotaxy: tarsi 2-2-0-0, tibiae I-1-1-I, genua 1-1-1-0.



32-35: *Streetacarus australis* spec.nov. Legs in dorsal view. 32 - leg I, 33 - leg II, 34 - leg III, 35 - leg IV.



Figs 36-44: *Streetacarus australis* spec.nov. 36 - Tritonymph anterior part in ventral view, 37 - in dorsal view, 38 - caudal part in ventral view, 39 - leg I, 40 - leg II, 41 - leg III, 42 - leg IV, 43 - larva in ventral view, 44 - larva in dorsal view.

**Larva:** similar to tritonymph in body shape and cuticular structure. Epimera I fused in V-shape; II shorter than in tritonymph. Propodosomal shield smaller, without lateral incisions. Caudal end rounded. Anal slit subterminal. No idiosomal setae observed. Three pairs of legs each with five free segments and smaller pretarsus than in tritonymph. Separation line of femur and genu in legs I and II on dorsal surface distinct. Sclerotized hooks on tarsi present. Solenidiotaxy: tarsi 1-1-0, tibia 1-1-1, genua 0-0-0. Setae very short or pointlike.

**Biology:** The species is viviparous, 8 of 38 females have been found with 1-2 well-developed larvae in the opisthosoma. Larval gnathosomata always directed toward caudal end.

**Host and locality:** *Calyptorhynchus magnificus*, Psittacidae, Psittaciformes, Mount Hart, 10-IX-1976, Lukoschus leg. Mites have been collected from quills of tails and upper tail coverts.

**Deposition of types:** Holotype and allotype in Perth. Paratypes in Chicago, Washington, Columbus, Brisbane, Prague, Antwerp, Nijmegen, Department of Entomology, Athens; Faculté de Médecine, Nice; Zoologisches Museum, Hamburg; British Museum (Natural History), London; Musée National d'Histoire Naturelle, Paris; Rijksmuseum van Natuurlijke Historie, Leiden.

## DISCUSSION

Species of Fainocoptinae are extraordinary in morphology and biology. They share a mixture of primitive characteristics and secondary adaptations to the biotope, as well as morphological deviant characteristics, not generally or quite unknown in astigmatic mites. Idiosomal and leg setae of unmodified seti- to filiform shape must be regarded as primitive, so to the long stalked empodial suckers. However the tarsal setation 6-7-4-5 is lower than in related families. The legs are only slightly modified for burrowing tissues; legs I and II are strong and shortened as in all burrowing animals (mites, insects, mammals). However, there is no fusion of tarsus and tibia as in *Knemidokoptes* or in subcutaneous hypopi like Echimyopinae and Muridectinae. There is only a partial dorsal fusion of segments femur and genu in the forelegs in the adult and nymphal stages. Absence of this fusion in the larvae and in larvae and adults of European species to be described later indicate the adaptative character of fusion. The stronger sclerotized feebly pronounced hooks of the tarsi are not modified for anchoring, although they maintain the mite in its feeding position. The winglike lateral appendages behind legs II also serve to anchor. The more dorsal position in developmental stages can be compared with those in *Saimirocopes* Fain, 1968. Additionally ventrolateral appendages are present on the gnathosoma as in Gastronyssidae Fain, 1956. Absences of vertical setae indicates the higher degree of skin or internal parasitism like the Psoroptidae, Pyroglyphidae, Gastronyssidae,

Cytoditidae, Epidermoptidae, Knemidokoptidae and Lobalgidae. Absence of genital discs in both sexes and of anadal or tarsal suckers in the male points in the same direction. The propodosomal shield with the typical strong sclerotization of the lateral borders is not only present in the Knemidokoptidae, but also in genera with a lower degree of parasitic adaptation like *Dermoglyphus* Mégnin, 1877 and *Paralges* Trouessart, 1885. The genital region of the female, with three valves, is of primitive shape; the epigynum and genital apodemes are not connected to sclerites. Copulatory opening is lying on a small tubercle dorsotermally. As in the Sarcoptidae and Knemidokoptidae the bursa copulatrix opens into the receptaculum seminis without chitinous appendages. The male genital region is shifted far to the opisthosoma while the genital setae do follow this shifting, it is not to the same extent so they are positioned between coxals IV and the genital apparatus. Pores behind humerals, in both sexes of some species, are doubtful in function. Ducts to dorsal or salivary glands have not been observed so far. The distinct gnathosoma articulated to the idiosoma by a 'neck-like' base must be regarded as a secondary adaptation for feeding of the elongated mite within the hard-walled tunnel. Not known in any family of astigmatic mites is the presence of two solenidia on tarsus II of tritonymphs. We regard it as a secondary adaptation rather than primitive. Presence of trochanter setae IV in both sexes is only known from the most developed species of the genus *Myialges* (Epidermoptidae). Fain (1965) has regarded it as hypertrichy. These setae have also been found by Atyeo in a new genus of feather mites (personal communication).

The special biotope is the feather quill during development of the feather. Species feed on the outer layers of the nonkeratinized quill. All stages feed in the same biotope on the same substrate. Chelicerae are adapted to this food: reduction of the fixed digit and strong development of the three-toothed digitus mobilis as in the description of the chelicerae of *Laminosioptes cysticola* by Fain (1956). It is not surprising to find mouthparts with almost the same morphology and size in all stages. There is only a short period to obtain suitable food during the development of the feather and a long period between the moults of the host, when feeding is impossible. Only the germ of the feather quill is suitable for feeding, thus mites have to move with the growing feather, otherwise they are shifted to keratinized regions and thus eliminated by the host. Mites found in full grown feathers are mostly moulting stages. Tritonymphs within the protonymphal skin exclude the possible suggestion that a heteromorphic deutonymph may be present, adapted to survive the long periods between moults of the host. The short time of suitable food and the speedy keratinization of the biotope surely has necessitated viviparity. In spite of the fact that there is only a short time for development, all developmental stages of both sexes are present: larva-protonymph-tritonymph-adults. Periods between moults of the host are survived by the adult female near to the base of the full grown feather.

TABLE I

Measurements (in  $\mu$ ) of 4 Australian quill wall mites belonging to the genera *Fainocoptes*, *Calamicoptes* and *Streptacarus*; idiosomatal characters.

	<i>F. nixonii</i>					<i>C. meliphagae</i>							
						<i>C. conopophilae</i>							
										<i>S. australis</i>			
	♀	♂	TrN	PrN	L	♀	♀	♂	TrN	♀	♂	TrN	L
total length	770	596	1029	658	224	495	442	245		655	638	710	292
width	195	194	268	221	73	164	147	139		211	237	217	111
length gnathosoma	70	72	47	39	29	59	54	52	38	68	68	44	34
width gnathosoma	81	74	53	47	33	52	50	47	40	64	64	51	40
length opisthosoma	252	179	489	301	90	155	153	87		213	163	276	125
length prod. shield	112	112	99	73	53	88	81	83	63	110	114	65	58
width prod. shield	76	74	48	29	24	64	63	65	55	89	88	56	32
dorsal 1	4	3				2	4	5		4	2		
dorsal 2	4	4				4	5	4		4	4		
dorsal 3	6	6				5	6	6		7	6		
dorsal 4	-	-				7	6	5		9	8		
dorsal 5	492	492				364	348	319		483	558		
lateral 1	134	106				62	43	37		98	38		
lateral 2	327	311				156	139	106		97	82		
lateral 3	160	130				95	96	76		52	45		
lateral 4	16	16				11	8	13		14	6		
lateral 5	288	300				282	273	208		345	267		
sc i	88	79				17	15	17		28	23		
sc e	330	332				172	171	106		229	225		
sh	76	68				40	34	27		24	29		
h	184	206				117	120	111		53	84		
g a	34	5				14	16	5		26	3		
g p	32	3				11	15	3		16	3		
a	67	3				3	14	2		15	2		
cx I	36	37				24	29	38		50	52		
cx III	50	45				35	36	31		53	47		
cx IV	79	22				40	43	39		49	21		
d 4 - 1 4	0	0				13	11	10		6	4		
length propod. alae	89	81	123	52	13	54	45	47		-	-	-	-
width propod. alae	38	27	91	39	9	23	19	16		-	-	-	-
d. palptarsal seta	5	4				3	3	3		3	4		
V. palptarsal seta	4	4				10	15	14		7	6		



TABLE II

Measurements (in  $\mu$ ) of 4 Australian quill wall mites belonging to the genera *Fainocoptes*, *Calamicoptes* and *Streetacarus*; characters of legs and solenidia and hairs of the legs.

	<i>F. nixonii</i>					<i>C. meliphagae</i>							
						<i>C. conopophilae</i>				<i>S. australis</i>			
	♀	♂	TrN	PrN	L	♀	♀	♂	TrN	♀	♂	TrN	L
leg I	66	59	42	33	22	57	54	53	34	74	74	44	28
leg II	67	58	40	30	20	55	53	53	32	78	80	38	27
leg III	135	120	43	25	16	94	90	84	29	138	134	43	26
leg IV	146	127	40	25	-	101	93	89	29	143	135	40	-
pretarsus I	24	23				25	24	22		28	29		
pretarsus II	25	29				31	29	27		35	34		
pretarsus III	42	43	4			31	29	32	4	39	40	6	
pretarsus IV	45	45	5			38	31	30	4	39	41	6	
ambulacrum I	8	7				9	9	11		10	11		
ambulacrum II	9	9				9	10	12		13	15		
ambulacrum III	12	14	6			11	11	12		14	14		
ambulacrum IV	13	13	6			12	11	13		14	14		
omega 1	40	32	4	3	3	17	15	17	8	20	20	4	4
leg I													
omega 3	28	27	2	-	-	27	22	20	5	23	24	3	-
omega 1	50	55	3	2	3	31	36	43	5	42	33	4	3
leg II													
omega 3	-	-	3	-	-	-	-	-	7	-	-	5	-
phi I	32	35	5	3	3	32	27	26	11	31	24	5	3
phi II	43	43	5	4	2	60	32	27	9	30	27	5	4
phi III	7	6	2	2		20	7	6	2	9	7	2	2
phi IV	5	61	2			5	3	18	2	6	20	2	
sigma I	25	16				26	19	18	4	24	19	4	
sigma II	6	5				4	5	5		8	6	2	
sigma III	3	3	1			-	-	-	-	5	5	2	
genu I seta	18	18				30	35	24		19	15		
genu II seta	43	33				43	52	41		73	77		
femur I seta	30	15				11	19	22		20	17		
femur II seta	75	60				39	67	62		92	96		
tarsus III seta	124	77				92	92	87		107	101		
tarsus IV seta	153	107				110	97	76		130	9		
trochanter III seta	101	91				30	32	26		38	41		
trochanter IV seta	104	92				30	31	26		35	32		

## ACKNOWLEDGEMENTS

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PARASITES OF WESTERN AUSTRALIA  
VIII  
MYOBIIDAE PARASITIC ON MARSUPIALS  
(ACARI: PROSTIGMATA)

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and  
F.S. LUKOSCHUS†

[Received 8 February 1978. Accepted 30 March 1978. Published 5 June 1979.]

ABSTRACT

The following new taxa are described from Australian Marsupials: *Australomyobia phascogale* sp.n. from *Phascogale calura*; *A. dasyurus* sp.n. from *Dasyurus hallucatus*; *A. dasycercus antechinus* subsp.n. from *Antechinus bilarni*. The male and the immature stages of *Australomyobia necopina* (Domrow, 1973), so far unknown, and *Acrobatobia queenslandica* Fain and Lukoschus, 1976 known only from a preliminary description, are described in detail and figured. A key to the *Australomyobia* spp. is given.

INTRODUCTION

In a previous paper we have studied the species of Myobiidae parasitic on bats. We deal now with the species that live on marsupials.

So far three species of Myobiidae have been described from Australian marsupials: *Australomyobia necopina* (Domrow, 1973), *Australomyobia dasycercus* Fain, 1973 and *Acrobatobia queenslandica* Fain & Lukoschus, 1976.

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In this paper we describe 2 new species and 1 new subspecies of the genus *Australomyobia* from various marsupials in Australia, mainly in the Western regions and we complete the description of *A. queenslandica*, which had only been briefly described.

FAMILY MYOBIIDAE Megnin, 1877

SUBFAMILY MYOBIINAE Megnin, 1877

TRIBE AUSTRALOMYOBINI Fain, 1973

### Genus *Australomyobia* Fain, 1973

Recently Fain (1978) has given a new and more complete description of this genus. We will only add here two remarks: 1) In the tritonymphs the legs I are symmetrical and the two pairs of coxal I setae are thick striated spines. 2) In the females the *l* 5 setae are thin and short and situated close to the *l* 4. In the males these setae are normally situated and in the nymphs they are distinctly ventral. 3) In the deutonymphs the trochanters IV bear a seta as in the tritonymph.

**Type species:** *Australomyobia dasycercus* Fain, 1973.

### Key to the genus *Australomyobia*

- Females -

(N.B. The female of *A. dasyurus* is unknown)

1. Posterior claw of legs II-IV 12-15 $\mu$  long. Base of *sc i* setae 4-6 $\mu$  thick. Base of setae *d* 1, *d* 2, *l* 2 with well-developed ventral expansion. Femur I 36 $\mu$  thick .....2  
 Posterior claw of legs II-IV 8-10 $\mu$  long. Base of *sc i* setae 15-18 $\mu$  thick. Base of setae *d* 1, *d* 2, *l* 2 without ventral expansion. Femur I 42-48 $\mu$  thick .....3
2. The *g* 1 setae are 120 $\mu$  long and 48 $\mu$  apart .....*A. necopina* (Domrow, 1973)  
 The *g* 1 setae are 80 $\mu$  long and 12 $\mu$  apart .....*A. phascogale* sp. nov.
3. Setae *sc i* progressively attenuated posteriorly.  
 The *g* 1 are 65 $\mu$  apart. Setae *ic* 4 and *cx* IV not distinctly inflated basally .....*A. dasycercus dasycercus*  
 Fain, 1973  
 Setae *sc i* abruptly narrowed posteriorly. The *g* 1 are 55 $\mu$  apart. Setae *ic* 4 and *cx* IV distinctly inflated basally .....*A. dasycercus antechinus* ssp. nov.

- Males -

(N.B. The male of *A. dasycercus dasycercus* and of *A. dasyurus* are unknown)

1. Genital plate bearing 3 external pairs of small setae and 3 internal pairs of much smaller and indistinct setae ..... 2  
 Genital plate bearing 3 external pairs of unequal conical spines, the posterior one being 9-10 $\mu$  long and 3,2 to 3,5 $\mu$  thick, and 3 internal pairs of very small setae ..... *A. dasycercus antechinus* ssp. nov.
2. Genital plate twice as wide (16 $\mu$ ) in its anterior half than in its posterior half (8 $\mu$ ), total length 21 $\mu$ . The *d 1* and *d 2* without ventral expansions ..... *A. necopina* (Domrow, 1973)  
 Genital plate oval, longer (18 $\mu$ ) than wide (15 $\mu$ ).  
 The *d 1* and *d 2* setae with ventral expansions ..... *A. phascogale* sp. nov.

## DESCRIPTION OF THE SPECIES

1. *Australomyobia necopina* (Domrow, 1973)  
*Archemyobia necopina* Domrow, 1973: 131  
*Australomyobia necopina*, Fain, 1978: 195 comb.nov.

Fain (1978) has given new figures of the female of this species. We give here the first description of the male and the immature stages.

**Male (Fig. 5):** Body 345 $\mu$  long and 210 $\mu$  wide. **Dorsum:** genital orifice situated at 15 $\mu$  behind the *sc e* setae. There are 6 pairs of genital setae: 3 pairs of externals 5-6 $\mu$  long and 3 pairs of internals much smaller. Penis 130 $\mu$  long. The *v i* are very small; the *sc i* are thicker and longer (18 $\mu$ ) and situated close to the *sc e*. The *d 1* are shorter (63 $\mu$ ) than the *d 2* (70 to 87 $\mu$ ). **Venter:** as in the female, except that the long pair of *g 1* setae are absent here and that the *l 5* are long and terminal. Legs and gnathosoma as in the female.

**Tritonymph:** our specimen has been collected on the typical host from Australia (animal in the Leiden Museum). Idiosoma 485 $\mu$  long and 270 $\mu$  wide. **Dorsum:** *v e*, *sc e* and *sc i* with a thick, striated and toothed base, and a very narrow apical part. The *v i* are small and situated between the *sc i*. The *d 1* to *d 5* and *l 1* to *l 5* are present. **Venter:** coxal setae 2-2-1-0; the coxals I are striated, shell-shaped. The *ic 2*, *ic 3* and *ic 4* are stout and 33 $\mu$ , 34 $\mu$  and 45 $\mu$  long respectively. The *l 5* is ventral and 120 $\mu$  long. Legs I symmetrical. Legs II-IV with a 2 unequal claws, trochanters with 1 setae. Trochanter IV with 1 seta.



**Deutonymph:** from the same host as the tritonymph. Idiosoma  $325\mu$  and  $205\mu$  wide. Similar to the tritonymph but the coxal setae are 2-1-0-0, the *ic* 4 are only  $27\mu$  long, the *l* 5 are  $120\mu$  long.

**Protonymph:** same origin as tritonymph. Idiosoma  $300\mu \times 195\mu$ . Similar to the deutonymph except for the following characters: coxal setae 1-0-0-0; the *ic* 4 are missing; there are no setae on the trochanters II to IV. The *l* 5 are  $120\mu$  long.

**Larva:** this specimen was collected on the typical host from Upper Allyn. Idiosoma  $190\mu \times 135\mu$ . Leg I-III as in protonymph. Idiosomal setae as in protonymph except that *d* 4, coxal I, *ic* 2 and *ic* 3 are missing.

**Prelarva:** the prelarva still included in the egg shell, is completely striated except in the anterior part of the dorsum which is bare. At the base of this bare area is a small median hook-like formation whose base is attached to two muscles inserted anteriorly. Ventrally, the anterior extremity presents a small rounded depression in which two short conical and sclerotized appendages are visible. These appendages are associated with deep-situated muscles and glandular organs.

#### Host and localities

1. This species has been described from female specimens collected on *Antechinus flavipes* (Waterhouse, 1838) (Dasyuridae), from Mount Magnificent, Australia. The holotype of this species is in the Australian National Insect Collection, Canberra.

The junior author collected several immatures and one male that belong to that species from the typical host specimen conserved in the Leiden Natural History Museum, collected in Australia, in March 1884.

From the same host, at Upper Allyn, N.S.W. 1.IX.1957, the junior author collected 4 females and 34 immature stages of the same species.

2. From Dr R. Domrow we received 2 nymphs from *Antechinus stuartii* Macleay, 1841, Poweltown, Victoria, 15.II.1974.

#### 2. *Australomyobia phascogale* sp. nov.

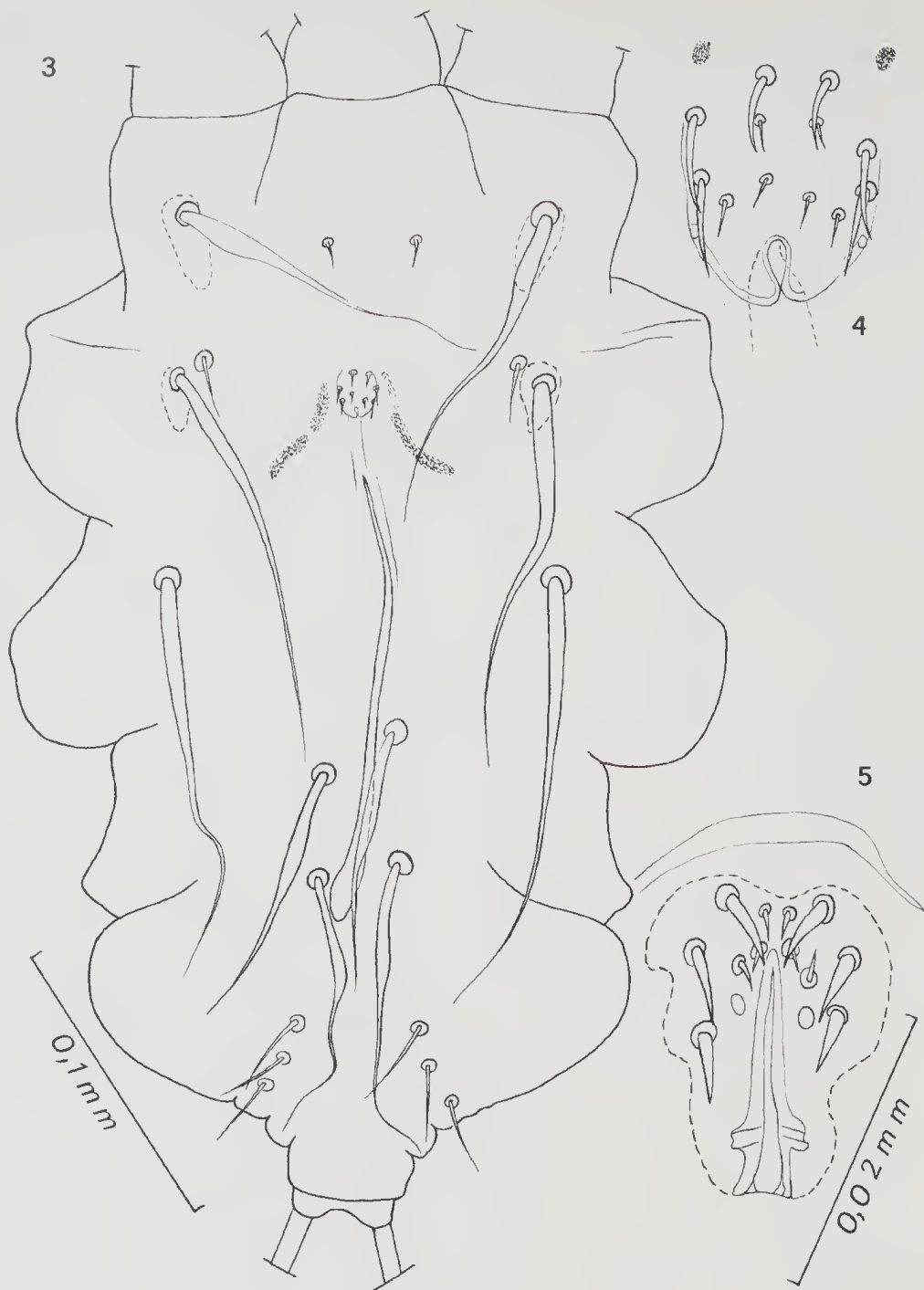
In the female of this species the small claws of legs II to IV are relatively long as in *A. necopina* ( $12\mu$ ,  $15\mu$ ,  $15\mu$  respectively). This species is however distinguished from the latter by the shape and the situation of the chaetotaxy. On the ventral surface the *g* 1 setae are much closer together (distance  $12\mu$  instead of  $48\mu$  in *A. necopina*); on the dorsum most of the setae show an inflation of the ventral surface more pronounced than in *A. necopina*. In this new species the setae of the legs are stouter than in the other species of the genus. The male is distinguished from those of *A. necopina* by a slightly different shape and structure of the genital plate, the greater size of the body, the different length and shape of some setae.

**Female (Fig. 1-2):** Holotype 525 $\mu$  long and 310 $\mu$  wide. **Dorsum:** the *v e*, *sc e*, *sc i*, *l 1*, *d 1* and *d 2* are 123 $\mu$ , 140 $\mu$ , 118 $\mu$ , 135 $\mu$ , 80 $\mu$  and 75 $\mu$ . Most of these setae are inflated ventrally in the posterior half of their thick basal part.

**Venter:** the *ic 4* and *cx IV* are not inflated basally. The *g 1* are 12 $\mu$  apart and 80 $\mu$  long. Legs: claws as in *A. necopina* but the small claws are a little longer than in that species. Leg I 120 $\mu$  long (from top of tarsus to base of trochanter); femur I 36 $\mu$  thick.



**Figs 1-2:** *Australomyobia phascogale* sp.n. Holotype female, venter and dorsum.



Figs 3-5: (figs 3-4) *Australomyobia phascogale* sp.n. Allotype male: (fig. 3) - dorsal view; (fig. 4) -genital area. (Fig. 5) *Australomyobia necopina* (Domrow). Male: genital area.

**Male (Fig. 3-4):** Allotype 390 $\mu$  long and 225 $\mu$  wide. **Dorsum:** genital plate longer than wide, bearing 6 pairs of small or very small setae. Penis 145 $\mu$  long. The *sc i* setae are thin and 15 $\mu$  long. The setae *d 1* and *d 2* are 75 $\mu$  and 90 $\mu$  long respectively and they are inflated as in the female. Legs as in the female.

### Host and locality

On *Phascogale calura* Gould, 1844, Lake Grace, 16.XII.1960 (host n° 6163, in the Western Australian Museum) (Holotype and 7 paratypes female, allotype and 2 paratypes male, 26 immature paratypes).

Types in the Western Australian Museum, Perth. Paratypes in Field Museum of Natural History, Chicago; Department of Zoology, Catholic University, Nijmegen, Netherlands; Institute of Tropical Medicine, Antwerp, Belgium.

### 3. *Australomyobia dasycercus* Fain, 1973

*Australomyobia dasycercus* Fain, 1973: 615; 1978: 195

This species has been described from *Dasycercus cristicauda*, Charlotte Waters, Central Australia (host n° 97.1.3.2., in the British Museum). It was only known from the female. The holotype is in the British Museum.

We have found on *Antechinus bilarni* several specimens which agree rather closely with *A. dasycercus*, except for several small differences, which justify the erection of a new subspecies.

### *Australomyobia dasycercus* ssp. *antechinus* subsp. nov.

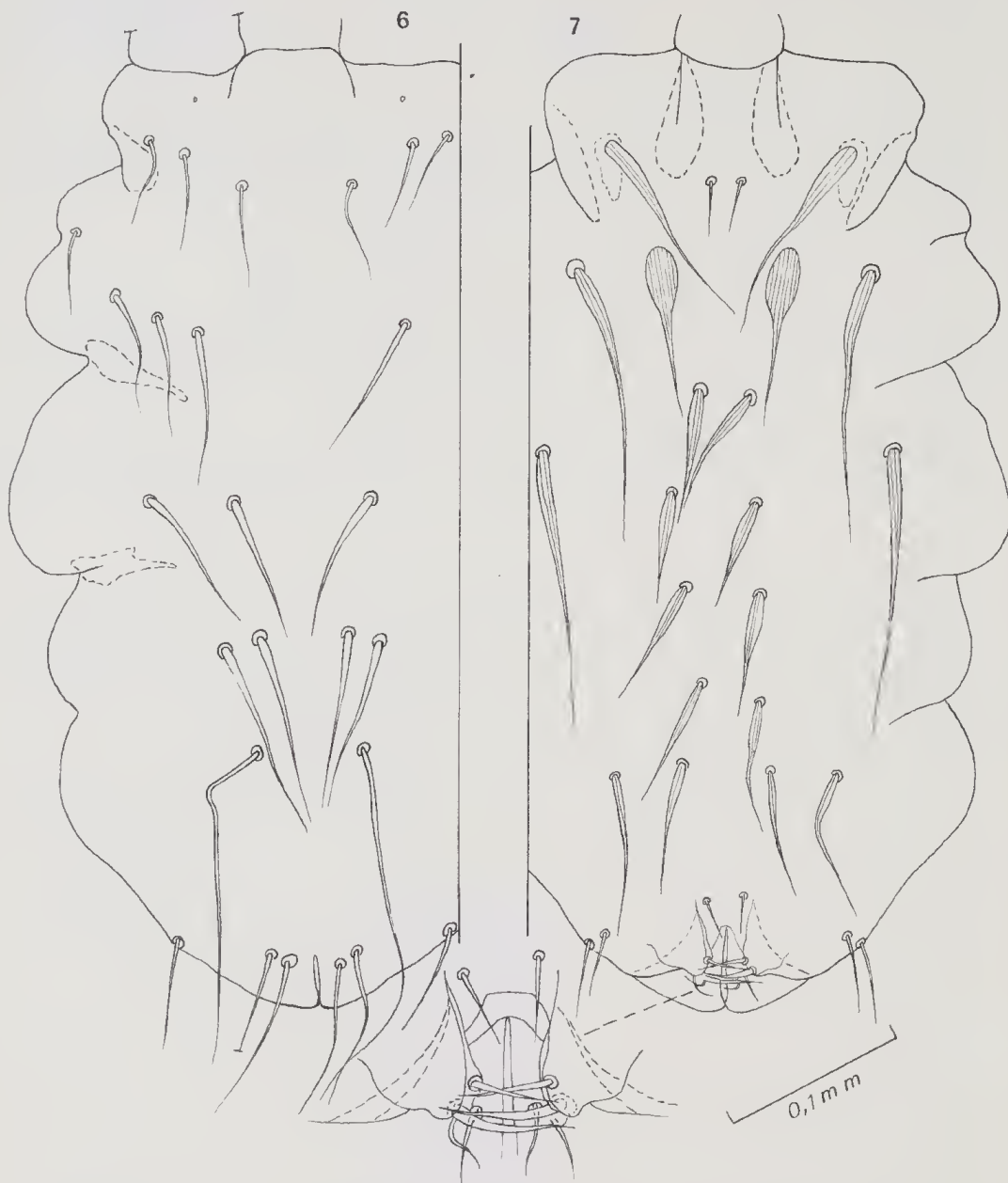
This subspecies is distinguished from the typical form in the female by the shape of the *sc i* setae which are more abruptly narrowed in their median part; the shape of the *ic 4* and *cx IV* setae more inflated basally; the situation of the *ic 4* and of *g 1* more close together; and the smaller length of the *d 1* and *d 2* setae.

**Female (Fig. 6-7):** Holotype 520 $\mu$  long and 315 $\mu$  wide. **Dorsum:** the setae *v e*, *sc e*, *sc i*, *l 1*, *d 1*, *d 2* are 120 $\mu$ , 150 $\mu$ , 90 $\mu$ , 150 $\mu$ , 72 $\mu$  and 60 $\mu$  long respectively. The basal half of *sc i* setae is 17-18 $\mu$  thick. **Venter:** coxal setae 2-3-1-1. All the *ic* are long. The *ic 4* are 42 $\mu$  apart. The *g 1* are very long (180 $\mu$ ). The small claws of legs II, III and IV are equal or subequal and 9 to 10 $\mu$  long. Leg I 120 $\mu$  long (from tip of tarsus to base of trochanter); femur I 21 $\mu$  thick. **Chaetotaxy of the legs II-IV:** Trochanters 3-3-3. Femora 5-3-3. Genua 7-7-7. Tibiae 6-6-6. Tarsi 7-6-6.

**Male (Fig. 8-9):** Allotype 420 $\mu$  long and 210 $\mu$  wide. **Dorsum:** genital orifice at 5-10 $\mu$  behind the level of *sc e* setae. Genital plate bearing 3 internal pairs of very small setae and 3 external pairs of thick but short spines. Penis 170 $\mu$  long, very thin apically and with one loop in its apical third. The *d 1* and *d 2* setae are 75 $\mu$  and 105 $\mu$  long respectively. The *d 3*, *d 4* and *l 4* are very thin and subequal in length (28-34 $\mu$ ). **Venter:** as in the female except that the *g 1* are missing and that the *ic 4* are much wider apart (distance *ic 4* - *ic 4* = 60 $\mu$ ).

## Host and locality

On *Antechinus bilarni* Johnson, 1964, Beverley Springs, 20.IX.1976 (host n° 2746) (holotype and 1 paratype female, allotype and 2 paratypes female, and 17 immature paratypes); 22.IX.1976 (host n° 2789) (16 immature paratypes). From Brooking Springs, 30.IX.1970 (host n° 2845) (20 immature paratypes).



Figs 6-7: *Australomyobia dasycercus antechinus* ssp.n. Holotype female, venter and dorsum.



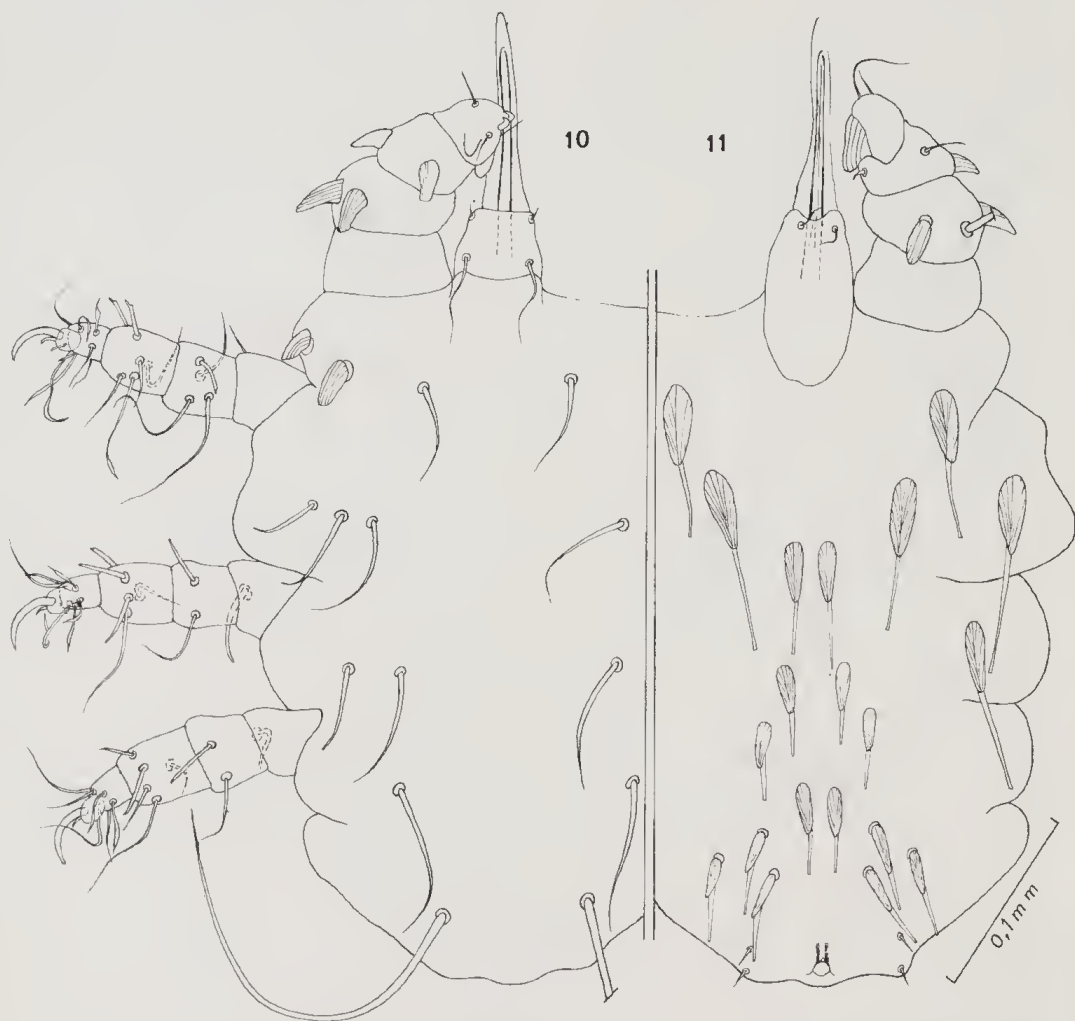


**Figs 8-9:** *Australomyobia dasycercus antechinus* ssp.n. Allotype male: (fig. 8) - dorsal view; (fig. 9) - genital area.

4. *Australomyobia dasyurus* sp. nov.

We have found on *Dasyurus hallucatus*, from two localities in Western Australia, 39 nymphs (tritonymphs and deutonymphs) belonging to the genus *Australomyobia*. These specimens differ from the trito- and deutonymphs of *A. necopina* and *A. dasycercus* by the following characters: the shape of the *vi* setae which are very thick, striated and similar to the *ve* setae, the larger the size of the body and the greater length of the *ic* setae. We think, therefore, that these specimens belong to a new species.

**Tritonymph (Fig. 10-11):** Holotype 390 $\mu$  long and 270 $\mu$  wide (idiosoma). Dorsal setae thick, striated and toothed. The *vi* setae are similar to the *ve* and situated between the *sc i*. Same number of dorsal setae as in tritonymph of *A. necopina*.



Figs 10-11: *Australomyobia dasyurus* sp.n. Holotype tritonymph, venter and dorsum.

**Venter:** coxal setae 2-2-1-0. The coxals I are thick and striated. The *ic* 2 - *ic* 4 are thick and 60 $\mu$ , 72 $\mu$  and 70-75 $\mu$  respectively.

**Deutonymph:** Idiosoma 348 $\mu$  long and 290 $\mu$  wide. Characteristics identical to the tritonymph, except that the coxal setae are less numerous 2-1-0-0.

### Hosts and localities

From *Dasycercus hallucatus* Gould, 1842, from Mitchell Plateau, 20-21.X.1976 (animal n° 3041 and 3056) (holotype, 5 paratype tritonymphs, and 1 paratype deutonymph); from Mount Hart, 11.IX.1976 (animal n° 2691) (29 deutonymph paratypes).

### Genus *Acrobatobia* Fain and Lukoschus, 1976

This genus is distinguished from the genus *Australomyobia* in the female, by the following characters:

1. Tarsus and tibia I distinctly reduced.
2. The *v e* and *sc i* foliate-striate, very large at their base, and with a very fine and short posterior prolongation.
3. Genital hooks abnormally large.
4. All the segments of leg II, except the tarsus, bear one or two strongly striated spines. Legs III-IV with spines on some segments.
5. Claws II very small and subequal. Claws III-IV strongly unequal.
6. Presence of a pair of short, cylindrical cuticular prolongations on the lateral surface of the opisthosoma.

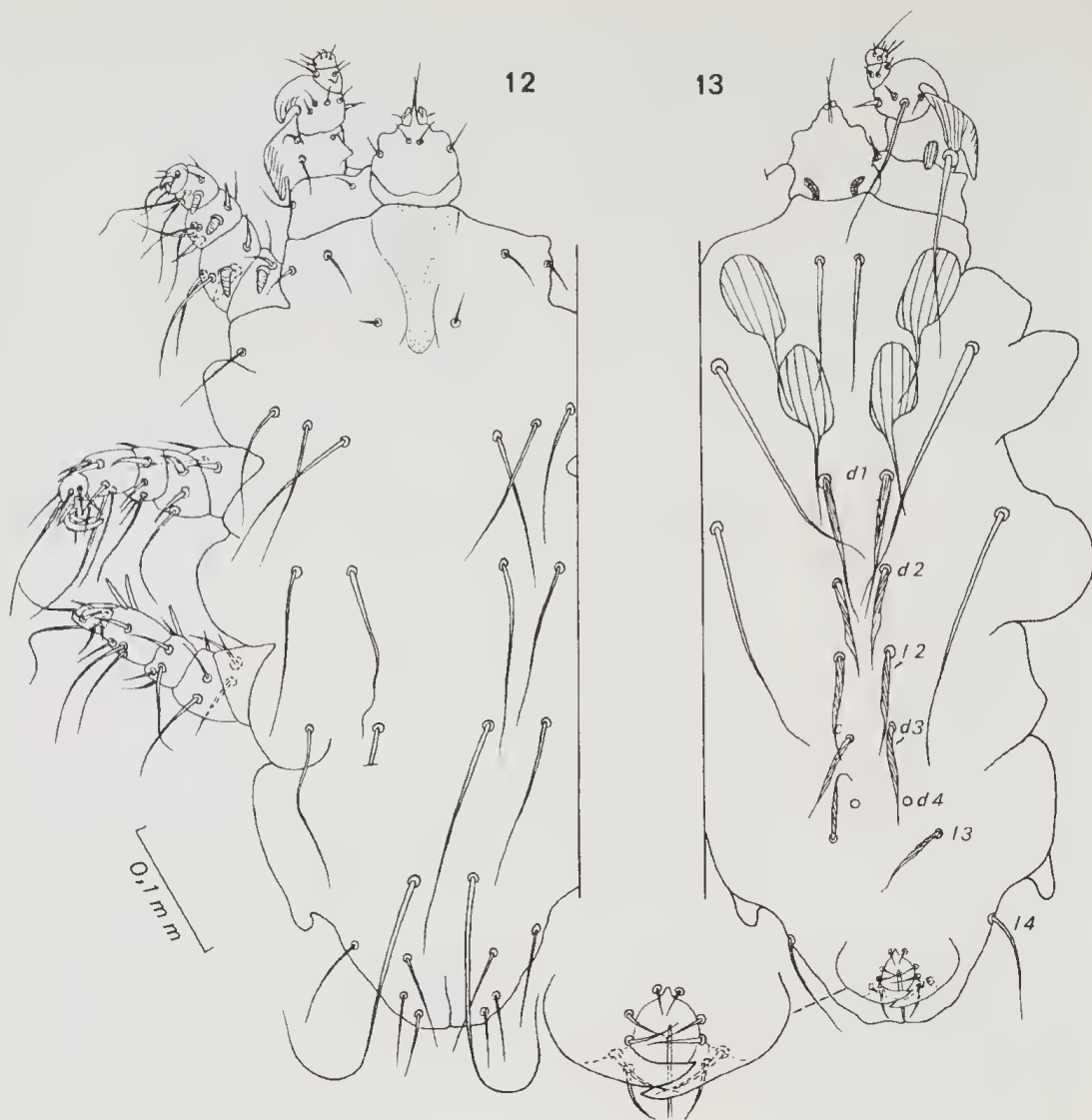
In the tritonymphs and deutonymphs the setae *v e* and *sc i* are identical to those of the female. The deutonymphs have only one pair of coxals I. Trochanteral setae of legs II-IV in tritonymph 1-2-2; in deutonymph 1-2-1.

**Type species:** *Acrobatobia queenslandica* Fain and Lukoschus, 1976.

*Acrobatobia queenslandica* Fain and Lukoschus, 1976: 180

Only the female and immatures are known.

**Female (Fig. 12-13):** Holotype 645 $\mu$  long and 330 $\mu$  wide. **Dorsum:** setae *v e* and *sc i* foliate-striate with a base 33-36 $\mu$  wide, and a very narrow posterior prolongation. The *v i* 90 $\mu$  long, the *sc e* and *l l* narrow and long. The *d l*, *d 2*, *l 2* with a distinct ventral expansion. Genital lobes very large. **Venter:** coxal setae 2-3-1-1. The *ic* 2 to *ic* 4 and the coxals II-IV are very long. The *g l* are 240 $\mu$  long. The opisthosoma bears laterally a pair of short, cylindrical cuticular prolongations. Legs II: with a big striated spine on the trochanter, 2 striated spines on femur and genu and one striated spine on the tibia. Leg I 135 $\mu$  long (from base of trochanter to apex of tarsus), femur I 45 $\mu$  wide.



Figs 12-13: *Acrobotia queenslandica* Fain & Lukoschus. Holotype female, venter and dorsum.

### Host and locality

On *Acrobates pygmaeus* (Shaw, 1793) from Armidale, Australia, 1916 (animal in the Smithsonian Collection) (holotype female); from Queensland, 11.VII.1893 (animal in the Hamburg Museum Collection) (9 nymphs) and from Sydney, 27.V.1911 (animal in the Hamburg Collection) (4 nymphs).

**Type:** in the U.S.N.M.

## ACKNOWLEDGEMENTS

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**PARASITES OF WESTERN AUSTRALIA**  
**IX**  
**MYOBIIDAE PARASITIC ON RODENTS**  
**(ACARINA: PROSTIGMATA)**

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and

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**ABSTRACT**

Six new species of Myobiidae parasitic on Australian rodents are described and figured. A key to subgenus *Syconycterobia*, typical for native rodents from Australia is given.

**INTRODUCTION**

In two previous papers we have studied the Myobiidae parasitising the Bats and the Marsupials in Australia (Fain and Lukoschus, 1979).

This paper is devoted to the study of this group of mites from Australian Rodents, mainly the species found in Western Australia.

The first record of myobiids from Rodents is that of Domrow (1955) who found *Radfordia ensifera* (Poppe) on *Rattus rattus* and *R. norvegicus* in Brisbane.

The cosmopolitan parasites of the Mouse *Mus musculus*, e.g. *Myobia musculi* (Schränk) and *Radfordia affinis* (Poppe), were reported by Domrow (1962) from Innisfail, North Queensland.

In 1963, Domrow described two new species of *Radfordia*: *R. fanningi* from *Melomys lutillus* in North Queensland, and *R. hornerae*, from *Rattus assimilis* in N.S.W.

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Fain (1973), erected a new subgenus *Syconycterobia*, in the genus *Radfordia* for a single specimen of a new species collected on a Bat in New Guinea. In 1974, this author transferred *Radfordia fanningi* Domrow into the subgenus *Syconycterobia*. In 1976, he described a new species belonging to that subgenus (*Radfordia (Syconycterobia) pseudomys*), from a rat, *Pseudomys hermansburgensis*, Ehrenberg Range, Central Australia.

In the present paper, we describe 5 new species of the subgenus *Syconycterobia*, from 3 different genera of Rats. These new findings show that in Australia this subgenus is almost entirely confined to the native genera of Rodents e.g. *Conilurus*, *Pseudomys*, *Zyomys*, *Mastacomys*, *Notomys* and *Melomys*. Amongst these genera only one, *Melomys*, is also represented in New Guinea and in other regions of Australasia.

It seems very probable that the typical host of the subgenus *Syconycterobia* (a Bat *Syconycteris crassa papua*, from New Guinea) was accidental and that the true host was more likely a Rat.

If we include the 5 new species described here, the total number of Myobiidae known from Australian Rodents is at present 11; they belong to 2 genera, *Radfordia* and *Myobia*.

The types of the new species have been deposited in the Western Australian Museum. Paratypes in Field Museum of Natural History, Chicago; Institute of Tropical Medicine, Antwerp; Department of Zoology, Catholic University of Nijmegen, The Netherlands.

#### Genus *Radfordia* Ewing, 1938

#### Subgenus *Syconycterobia* Fain, 1973

This subgenus is characterized in the adults by the presence of a very long and strong dorsal seta on trochanter IV and the absence of any dorsal seta on trochanter III. The trochanters II-IV bear 3-2-3 setae respectively. Coxal setae 3-3-1-1 or 3-2-1-1. Genua II to IV with 7-6-5 setae. In the females the *sc i*, *sc e*, *l 1* and sometimes the *d 2* and *l 2* have a bifid apex.

In the tritonymphs the legs I are symmetrical, the legs II and III bear a single claw and the leg IV is devoid of claws. Most of dorsal setae are membraneous and transparent and the *d 2*, *d 3*, *l 2* and *l 3* are generally situated very close to each other and twisted.

Type species: *Radfordia (Syconycterobia) syconycteris* Fain, 1973.

**Hosts:** Native genera of Rodents of Australia (*Pseudomys*, *Notomys*, *Mastacomys*, *Conilurus*, *Zyomys*) and also on *Melomys*, which is also represented in other regions of Australasia. The presence of the type species on a bat was probably accidental.

## KEY TO THE SUBGENUS SYCONYCTEROBIA

- Females -

(N.B. The female of *R.(S.) mastacomys* is unknown)

1. Setae *v i* very thick and much longer ( $100\mu$ ) than the *v e* ( $60\mu$ ). The *sc i*, *sc e*, *l 1*, *l 2* and *d 2* very thick and subequal in width ..... *R.(S.) notomys* sp. nov.  
 Setae *v i* thinner and either equal in length or shorter than the *v e* ..... 2
2. The *sc e* distinctly longer than *sc i* ..... 3  
 The *sc e* shorter than the *sc i* ..... 5
3. Setae *d 2* and *l 2* are  $9\mu$  thick and  $135-140\mu$  long; the *l 1* are  $9\mu$  thick and  $165\mu$  long; most of dorsal setae with their apex deeply divided. The *v i* as long as the *v e*. Body twice as long ( $426\mu$ ) as wide ( $210\mu$ ) ..... *R.(S.) zyzomys* sp. nov.  
 Setae *d 2* and *l 2* distinctly thicker than *l 1*; dorsal setae much shorter and not deeply divided at apex. Body more elongate ..... 4
4. Body  $380-442\mu$  long and  $245-285\mu$  wide (ratio 1,6:1). Setae *ic 3* are  $120\mu$  apart, they are closer to the lateral border of the body than to the midline. Setae *sc e*, *sc i*, *l 1*, *d 2* and *l 2* are  $99\mu$ ,  $81\mu$ ,  $105\mu$ ,  $96\mu$  and  $96\mu$  long respectively. The *d 2* and *l 2* are distinctly expanded in their posterior half ..... *R.(S.) latior* sp. nov.  
 Body  $330-336\mu$  long and  $183-186\mu$  wide (ratio 1,8:1). Setae *ic 3* are  $75\mu$  apart, they are closer to the midline than to the lateral border of the body. Setae *sc e*, *sc i*, *l 1*, *d 2* and *l 2* are  $78\mu$ ,  $66\mu$ ,  $76\mu$ ,  $75\mu$  and  $75\mu$  long respectively. The setae *d 2* and *l 2* are slightly thicker basally than apically ..... *R.(S.) vesca* sp. nov.
5. The *l 1*, *l 2* and *d 1* subequal in length and thickness ..... *R.(S.) pseudomys* Fain, 1976  
 The *l 1* much thinner and shorter than *d 2* and *l 2* ..... 6

6. Setae *v i* 52 $\mu$  long and relatively thick; the *d 2* and *l 2* are 130 $\mu$  and 115 $\mu$  long respectively. The coxal IV much longer (18-20 $\mu$ ) than the *ic 4* (7 $\mu$ ). Leg setae short. Coxal setae 3-3-1-1 ..... *R.(S.) syconycteris* Fain, 1973  
 Setae *v i* 25-30 $\mu$  long and narrow; the *d 2* and *l 2* are 100 and 110 $\mu$  long respectively. The coxal IV as long as the *ic 4* (6 $\mu$ ). Most of the leg setae longer. Coxal setae 3-2-1-1 ..... *R.(S.) fanningi* Domrow, 1963

- Males -

(N.B.1: The males of *R.(S.) syconycteris*, *R.(S.) pseudomys* and *R.(S.) vesca* are unknown. We have not seen the male of *R.(S.) fanningi*.

2: For nomenclature of genital and dorsal setae see the paper of Fain and Lukoschus, 1977).

1. Setae *ic 4* thick and 48-51 $\mu$  long; setae *d 1* very thick (7-8 $\mu$ ) and long (130 $\mu$ ) ..... *R.(S.) mastacomys* sp.nov.  
 Setae *ic 4* thin and not longer than 15 $\mu$ ; setae *d 1* much thinner and not longer than 60 $\mu$  ..... 2
2. Seta *d 2* is thicker and longer (85 $\mu$ ) than *d 1* (55 $\mu$ ) ..... *R.(S.) zyzomys* sp.nov.  
 Seta *d 2* is thinner and shorter than *d 1* ..... 3
3. Setae *sc i* very thin, non-toothed and 12 $\mu$  long; the *d 1* are about twice as long (42-48 $\mu$ ) as the *d 2* (22-24 $\mu$ ). Setae *ic 1* thin and short (10 $\mu$ ) ..... *R.(S.) notomys* sp.nov.  
 Setae *sc i* thicker, toothed and 21 $\mu$  long; the *d 1* about 1,5 time longer (40-48 $\mu$ ) than *d 2* (29-36 $\mu$ ).  
 Setae *ic 1* thick and 30 $\mu$  long ..... *R.(S.) latior* sp.nov.

1. *Radfordia (Syconycterobia) mastacomys* sp.nov.

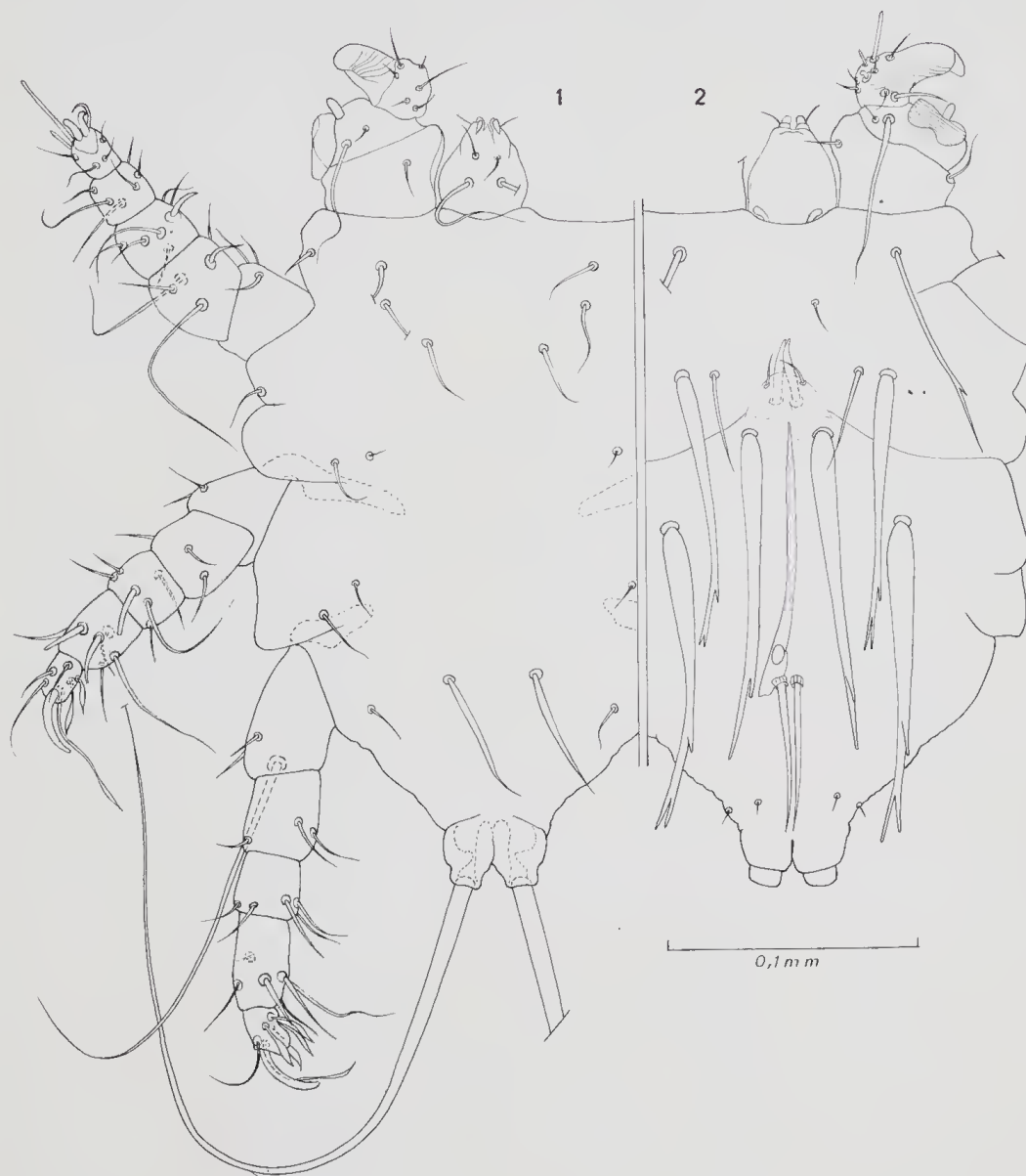
**Male (Fig. 1-2):** Holotype 302 $\mu$  long and 194 $\mu$  wide. **Dorsum:** genital aperture at 15 $\mu$  behind the base of *sc e*. Penis 90-95 $\mu$  long. The *sc i* are thin and 39 $\mu$  long. The *d 1* are very thick (7-8 $\mu$ ) and very long (130 $\mu$ ); the *d 2* are 60 $\mu$  long. Setae *l 1* very thick in their basal half (10-11 $\mu$ ) and with a bifid apex. **Venter:** coxal setae 3-2-1-1. The *ic 4* are thick and 48-51 $\mu$  long (until 60 $\mu$  in paratypes). The internal coxals III-IV are thicker and longer than the *ic 3* and *ic 4*. Legs relatively long. The genu II bears a cylindroconical recurved spine.

**Female:** unknown.



## Host and locality

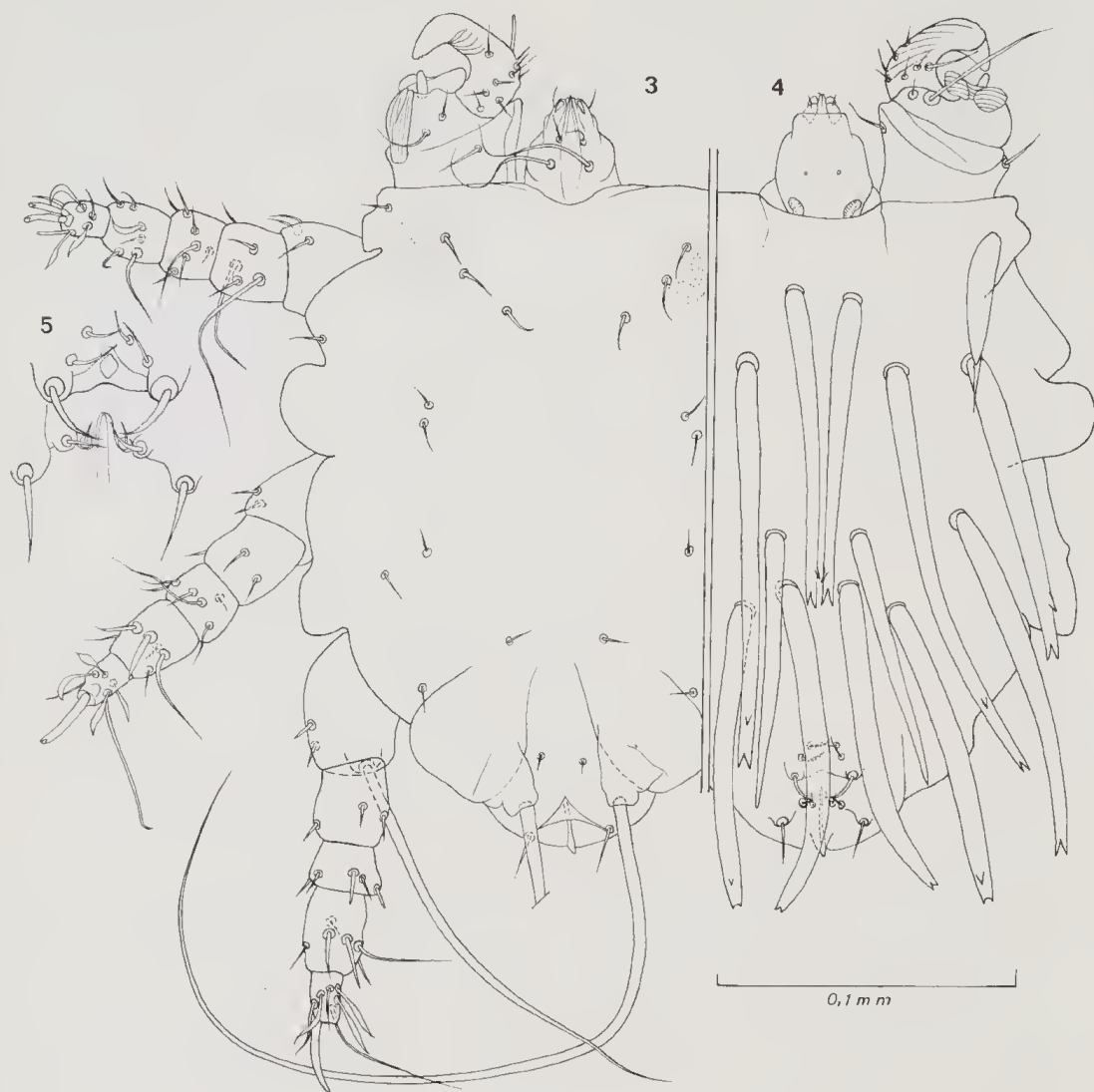
On *Mastacomys fuscus* Thomas, 1882, White's River, N.S.W., 11.II.1958 (rat n° M5285, in the collection of Western Australian Museum) (holotype and 6 paratypes male, 10 nymphs).



**Figs 1-2:** *Radfordia (Syconycterobia) mastacomys* sp.n. Holotype male. **Fig. 1** - ventrally; **Fig. 2** - dorsally.

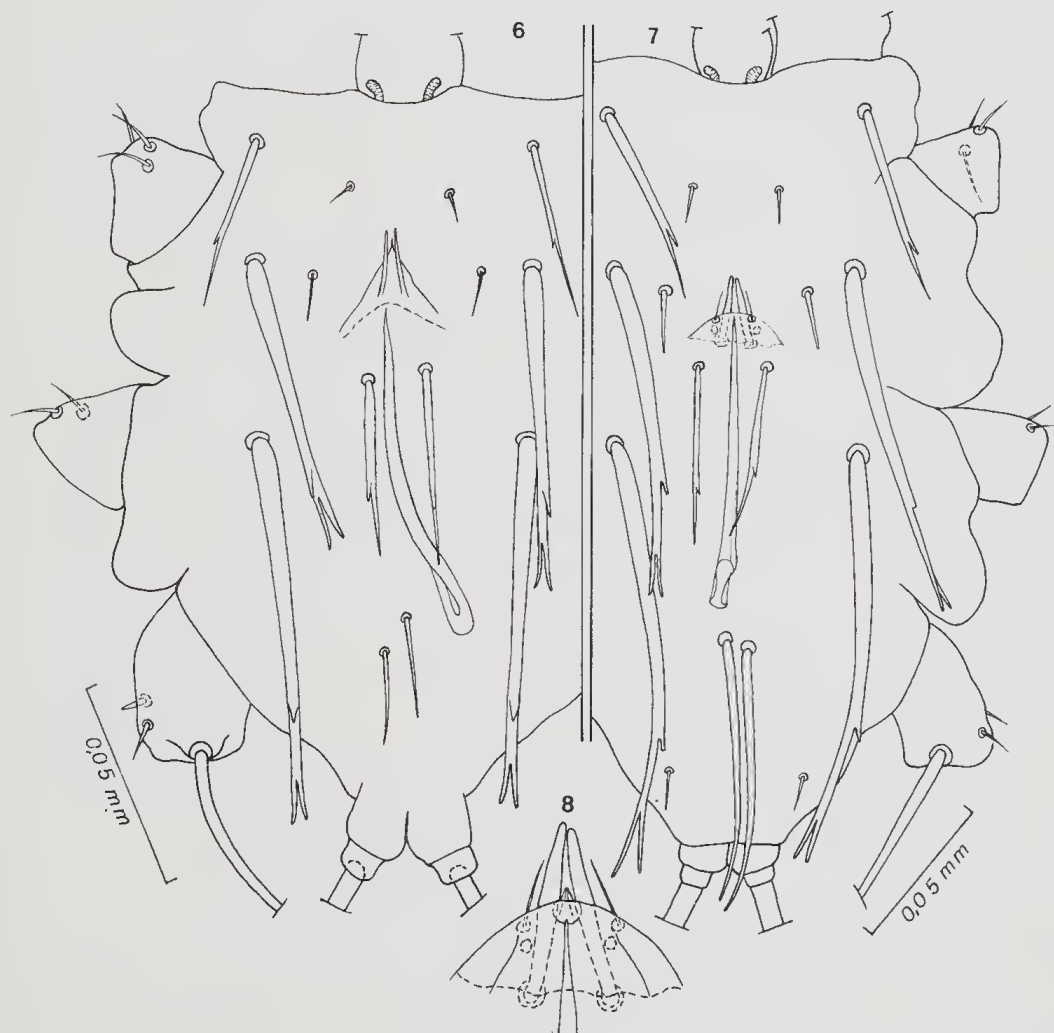
2. *Radfordia (Syconycterobia) notomys* sp.nov.

**Female (Figs 3-5):** Holotype 250 $\mu$  long and 190 $\mu$  wide. **Dorsum:** most of dorsal setae are cylindroconical, very thick and long; the *v i*, *sc i*, *sc e*, *l l*, *d 1* and *d 2* are 105 $\mu$ , 132 $\mu$ , 108 $\mu$ , 120 $\mu$ , 90 $\mu$  and 108 $\mu$  long respectively; some have a bifid apex. Genital lobes un conspicuous, the *g 7* setae are thin. **Venter:** coxal setae: 3-2-1-1. The *ic 2* to *ic 4* are very small. Legs: leg IV distinctly longer than leg III; femora and genua II to IV with thin, not spinelike setae. Genua II-IV with 7-6-5 setae.



**Figs 3-5:** *Radfordia (Syconycterobia) notomys* sp.n. Holotype female. **Fig. 3** - ventrally; **Fig. 4** - dorsally; **Fig. 5** - genital area.

**Male (Fig. 6):** Allotype 219 $\mu$  long and 146 $\mu$  wide. **Dorsum:** genital aperture at 10 $\mu$  behind the level of *sc e* setae. The *v i* and *sc i* setae are very thin, they are 5 $\mu$  and 10 $\mu$  long. The *d 1* are thicker and longer (42-48 $\mu$ ) than the *d 2* (22-24 $\mu$ ). (In the paratype from *Notomys alexis*, the *d 1* and *d 2* are 57 $\mu$  and 42 $\mu$  long respectively.) The *v e* are thin and 42 $\mu$  long; the *sc e* and *l 1* are much thicker, their apex is bifid and they measure 80 $\mu$  and 94 $\mu$  long respectively. **Venter:** *ic 3* widely separated (87 $\mu$  apart) and closer to the lateral margin of the body than to the midline. The *ic 1* is thin and short 10 $\mu$ . Legs IV distinctly longer than leg III.



**Figs 6-8:** Fig. 6 - *Radfordia (Syconcterobia) notomys* sp.n. Allotype male dorsally. Fig. 7,8 - *Radfordia (Syconcterobia) zyzomys* sp.n. Allotype male (7); genital area (8).

**Tritonymph:** a specimen containing a female is  $318\mu$  long and  $240\mu$  wide. Tarsus IV without claw but with 4 strong hairs amongst which 2 are bifid. Dorsal hairs very long and wide, they are membraneous and excessively transparent except for a central axis which is slightly sclerotized; the posterior setae are strongly curved.

**Deutonymph:** length  $215\mu$ , width  $210\mu$ . The leg IV is lacking. Dorsal setae as in tritonymph.

#### Host and locality

1. On *Notomys* sp., Kalbarri, Western Australia, 13.V.1965 (rat n° M6698, in the Western Australian Museum) (holotype and 12 paratypes female, allotype and 1 paratype male, 12 nymphs paratypes).
2. On *Notomys alexis* Thomas, 1922, Wanjarri Park, 8.I.1975 (rat n° M12964, in the Western Australian Museum) (4 females, 1 male and 10 nymphs, all paratypes). From the same host, in Miss Gibson Hill, 16.III.1975 (rat n° M13330 in the W.A.M.) (1 female and 1 nymph, paratypes).

#### 3. *Radfordia (Syconycterobia) zyzomys* sp.nov.

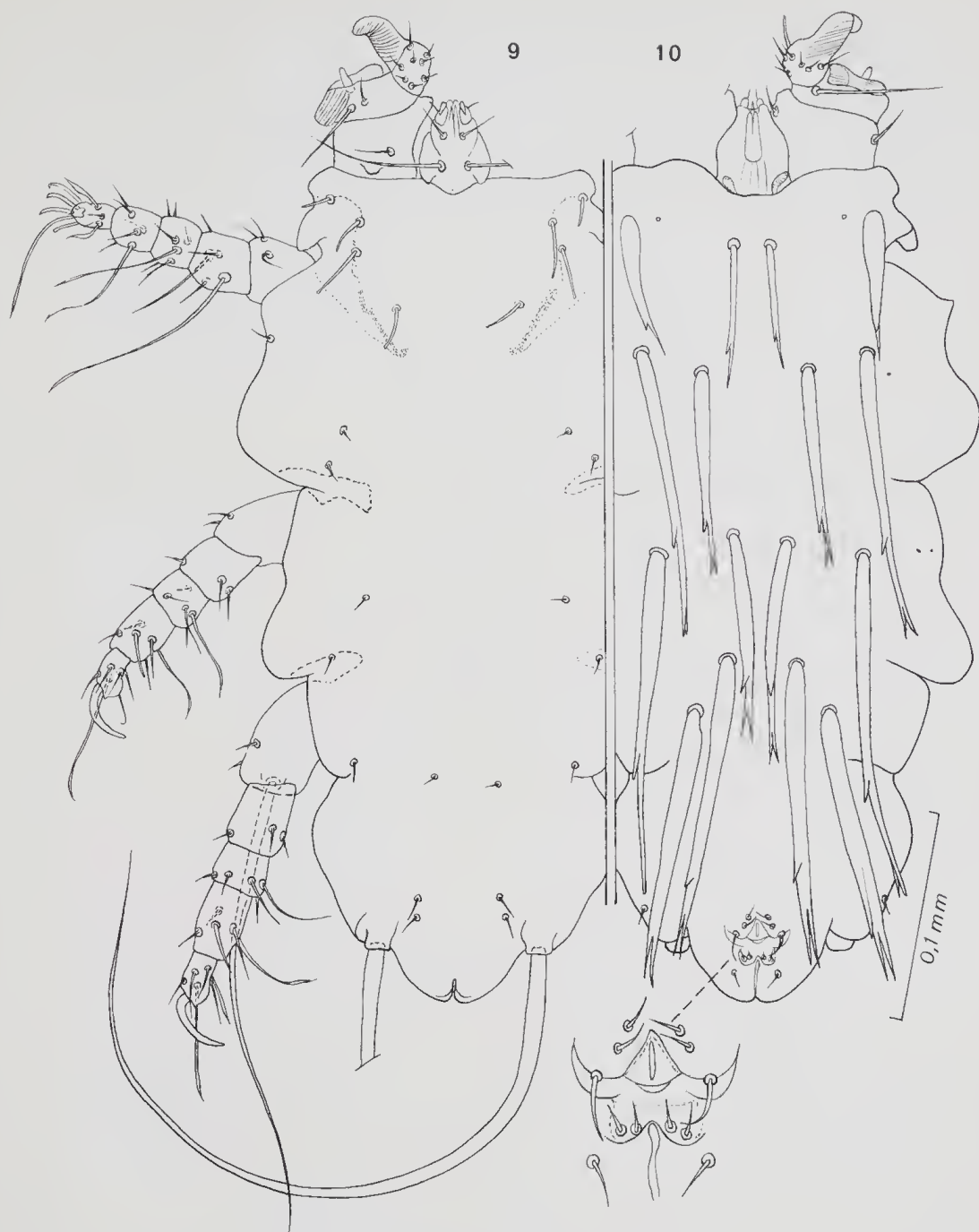
**Female (Figs 9-10):** Holotype  $426\mu$  long and  $210\mu$  wide. **Dorsum:** the  $v\ i$  are much narrower than the  $v\ e$  but approximately as long as the latter. Setae  $sc\ e$  much longer ( $135\mu$ ) than the  $sc\ i$  ( $96\mu$ ); these setae, as well as the  $d\ 1$ ,  $d\ 2$ ,  $l\ 1$  and  $l\ 2$ , are deeply incised at their apex. The setae  $d\ 2$ ,  $l\ 2$  and  $l\ 1$  are equally thick ( $9\mu$ ). There are no distinct genital lobes. The  $g\ 7$  setae very thin. **Venter:** coxals II-IV and  $ic\ 2$  to  $ic\ 4$  very small, the coxals I and  $ic\ 1$  are stout rods of  $18-25\mu$  long. Gnathosoma bearing ventrally a pair of very long posterior setae. Legs IV distinctly longer than legs III and II.

**Male (Figs 7-8):** Allotype  $291\mu$  long and  $165\mu$  wide. **Dorsum:** genital aperture at  $15\mu$  behind the level of  $sc\ e$  setae. Penis straight,  $90\mu$  long. The  $sc\ i$  are thick rods,  $18\mu$  long. The  $d\ 1$  are thinner and shorter ( $55\mu$ ) than the  $d\ 2$  ( $85\mu$ ). The  $v\ e$ ,  $sc\ e$  and  $l\ 1$  are  $66\mu$ ,  $114\mu$  and  $132\mu$  long respectively. The  $sc\ e$  and  $l\ 1$  are deeply divided at their apex. **Venter:** legs and gnathosoma as in the female.

**Tritonymph:** resembling that of *R.(S.) notomys* but the tarsus IV bears 4 thick and not furcate setae.

#### Host and locality

On *Zyzomys argurus* (Thomas, 1889), Napier Downs, Western Australia, 30.VIII to 2.IX.1976 (rats n° 2660, 2637 and 2638) (Holotype and 7 paratypes female, allotype and 3 paratypes male, 29 paratypes nymph); Brooking Springs, 29.IX. 2.X. and 28.XI.1976 (rats n° 2806, 2832 and 2883) (2 females, 1 male and 3 nymphs, paratypes); Beverley Springs, 22.XI.1976 (rat n° 2792) (1 female, 5 males and 1 nymph, paratypes).



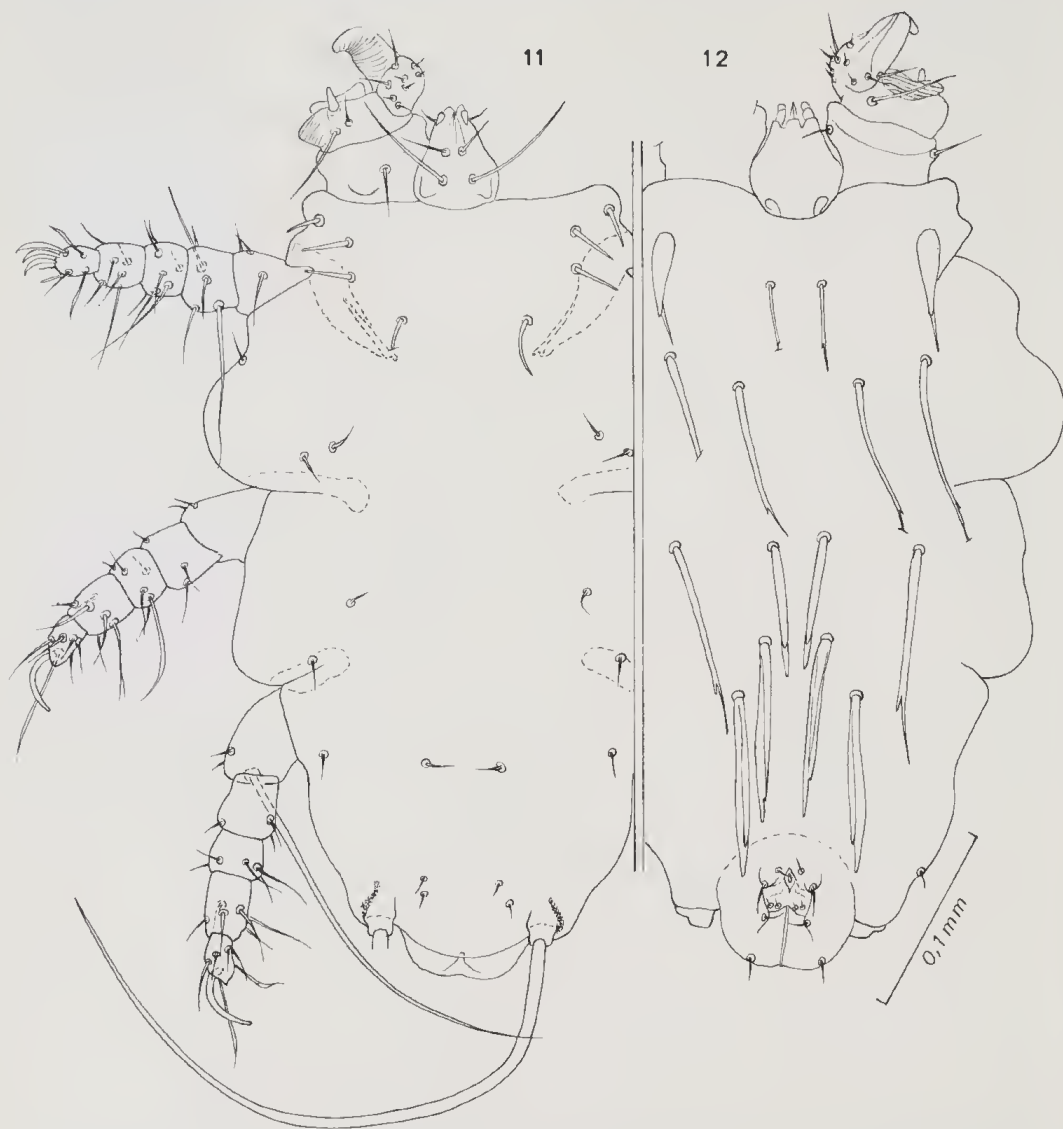
**Figs 9-10:** *Radfordia (Syconycterobia) zyzomys* sp.n. Holotype female. **Fig. 9** - ventrally; **Fig. 10** - dorsally.



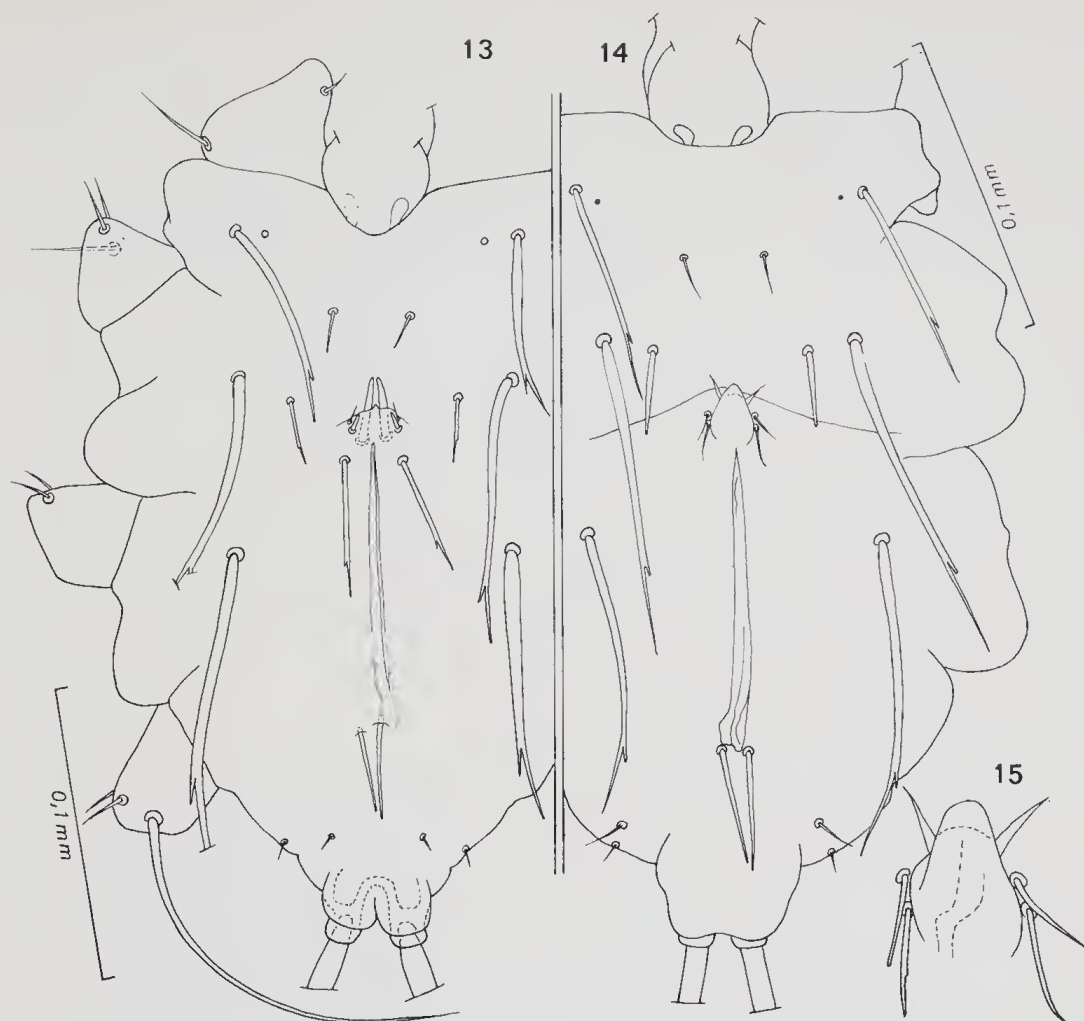
4. *Radfordia (Syconycterobia) latior* sp.nov.

**Female (Figs 11-12):** Holotype 442 $\mu$  long and 270 $\mu$  wide. In 4 paratypes the length and the width are 429 x 255 $\mu$ ; 419 x 280 $\mu$ ; 390 x 250 $\mu$  and 380 x 245 $\mu$  respectively.

**Dorsum:** the *v i* are narrow and toothed and 36-45 $\mu$  long. The *v e* are inflated basally and also toothed, they are 63 $\mu$  long. The *sc i* are shorter (81 $\mu$ ) than the *sc e* (96 $\mu$ ). The *d 2* and *l 2* are inflated in their apical half (8 $\mu$  wide) and are much thicker but shorter (90 $\mu$ ) than the *l 1* (105 $\mu$ ). Genital lobes absent, the *g 7* setae are small.



**Figs 11-12:** *Radfordia (Syconycterobia) latior* sp.n. Holotype female. **Fig. 11** - ventrally; **Fig. 12** - dorsally.



**Figs 13-15:** Fig. 13 - *Radfordia (Syconycterobia) latior* sp.n. Allotype male dorsally. Figs 14,15 - *Radfordia (Radfordia) australiana* sp.n. Allotype male dorsally (14); genital area (15).

**Venter:** the *ic 1* and the coxals I are much longer ( $22-30\mu$ ) and much thicker than the *ic 2 - ic 4* and the coxals II-IV. Coxal setae: 3-2-1-1. Distances *ic 3 - ic 3* =  $120\mu$ , *ic 4 - ic 4* =  $36\mu$ . The *g 1* and *g 2* are rodlike and short. Legs IV slightly longer than leg III. Tarsal part of fused first segment of legs I with a large foliate anterior seta.

**Male (Fig. 13):** Allotype  $294\mu$  long and  $198\mu$  wide. **Dorsum:** genital orifice at  $20\mu$  behind the level of *sc e*. Penis  $80\mu$  long. The *sc i* are  $23\mu$  long, they are cylindrical and toothed. The *d 1* are toothed and  $45\mu$  long, the *d 2* are not toothed and  $36\mu$  long. The *v e* are shorter ( $63-70\mu$ ) than the *sc e* ( $90\mu$ ). **Venter:** as in the female except that the *ic 4* are thicker and longer ( $15\mu$ ). Legs as in the female.

### Host and locality

On *Conilurus penicillatus* (Gould, 1842), Port Warrender, Western Australia, 31.X.1976 (rat n° 1349) (holotype and 4 paratypes females, allotype and 3 paratypes males, 8 paratypes nymphs) and 29.X.1976 (rat n° 3110) (2 female paratypes).

We attribute provisionally to *R.(S.) latior* two specimens (1 female and 1 male) from the same host and locality (rat n° 3159), which differ from the typical series mainly by the smaller size of the body in the female (325 x 210 $\mu$ ).

#### 5. *Radfordia (Syconycterobia) vesca* sp.nov.

**Female (Figs 16-17):** Holotype 369 $\mu$  long and 210 $\mu$  wide. **Dorsum:** setae *v e*, *v i*, *sc e*, *sc i*, *d 1*, *d 2*, *l 1* and *l 2* are 66 $\mu$ , 45 $\mu$ , 78 $\mu$ , 66 $\mu$ , 57 $\mu$ , 75 $\mu$ , 76 $\mu$  and 75 $\mu$ . Absence of genital lobes, the *g 7* are small. **Venter:** coxal setae 3-2-1-1. Coxals I and *ic 1* thicker and longer than *ic 2* - *ic 4* and coxals II-IV. The *ic 4* are longer and stronger than *cx IV* (6 $\mu$ ). Distances *ic 3* - *ic 3* = 75 $\mu$ , *ic 4* - *ic 4* = 30 $\mu$ . Legs IV distinctly longer and stronger than leg III. Leg setae relatively thin and long. Tarsus I with an anterior foliate seta. Trochanters I with a rounded ventral prolongation. Ventral surface of gnathosoma with two posterior pointed prolongations.

**Male:** unknown.

### Host and locality

On *Pseudomys nanus* (Gould, 1859), Mitchell Plateau, 20.X.1976 (rat n° 3029) (holotype and 1 paratype females).

#### 6. *Radfordia (Syconycterobia)* sp.

This species is represented only by two nymphs and a male in bad condition, with most of the setae lost or incomplete. Body of the male 255 $\mu$  x 135 $\mu$ .

**Host:** *Mesembriomys macrurus* Peters, 1876, Mitchell Plateau, 22.X.1976 (rat n° 3062).

#### Subgenus *Radfordia* Ewing, 1938

##### 1. *Radfordia (Radfordia) affinis* (Poppe, 1896)

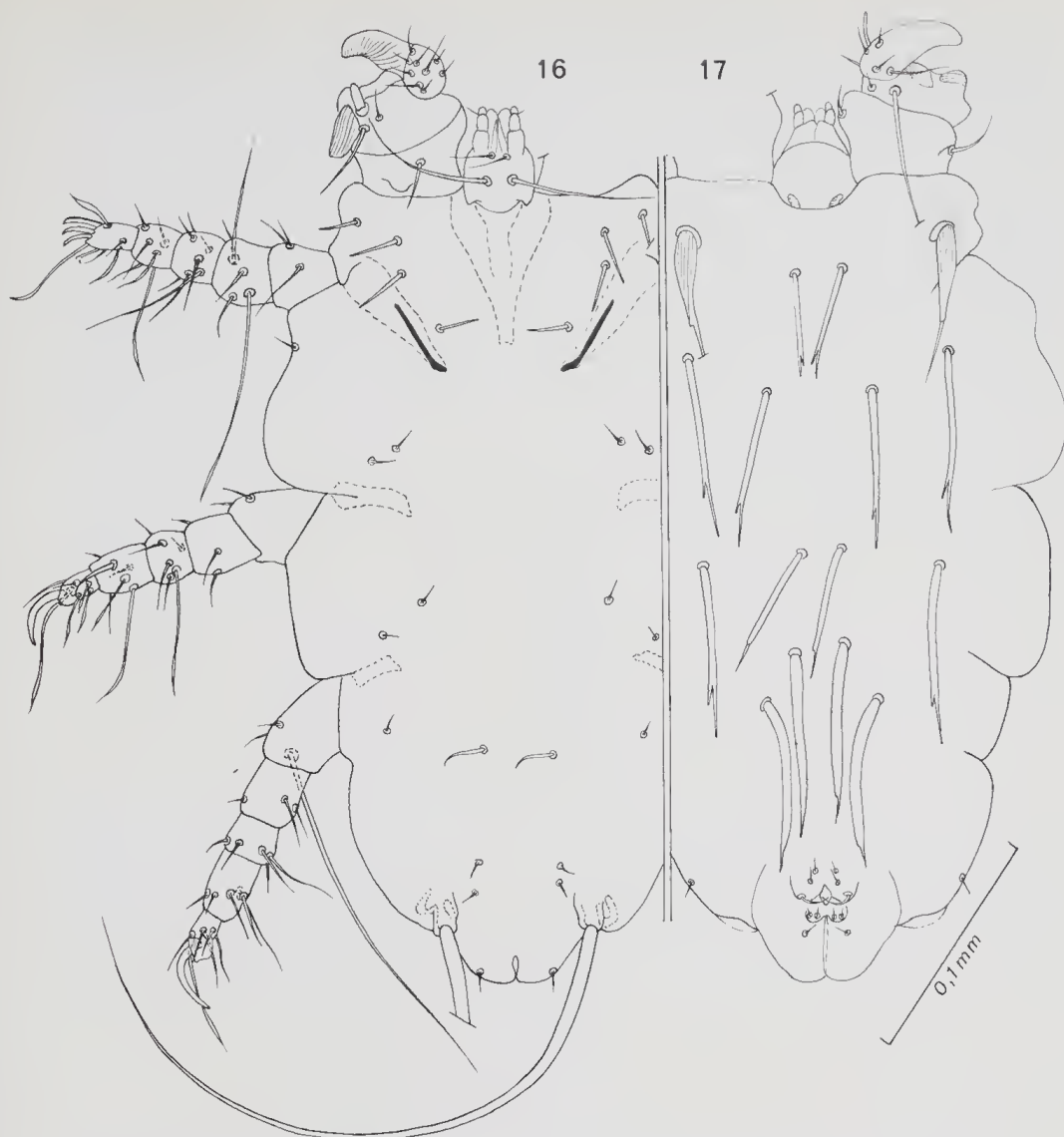
This species has been reported from *Mus musculus* in Australia by Domrow (1962).

We have found this species on the same host in Brooking Springs, 28.IX.1976 (host n° 2808) (1 male and 1 female).

##### 2. *Radfordia (Radfordia) ensifera* (Poppe, 1896)

This cosmopolitan species has been reported from *Rattus norvegicus* and *R. rattus*, in Australia (Domrow, 1955).

We have found on *Rattus rattus*, from Beagle Bay, 28.III.1976, several female specimens belonging to this species.



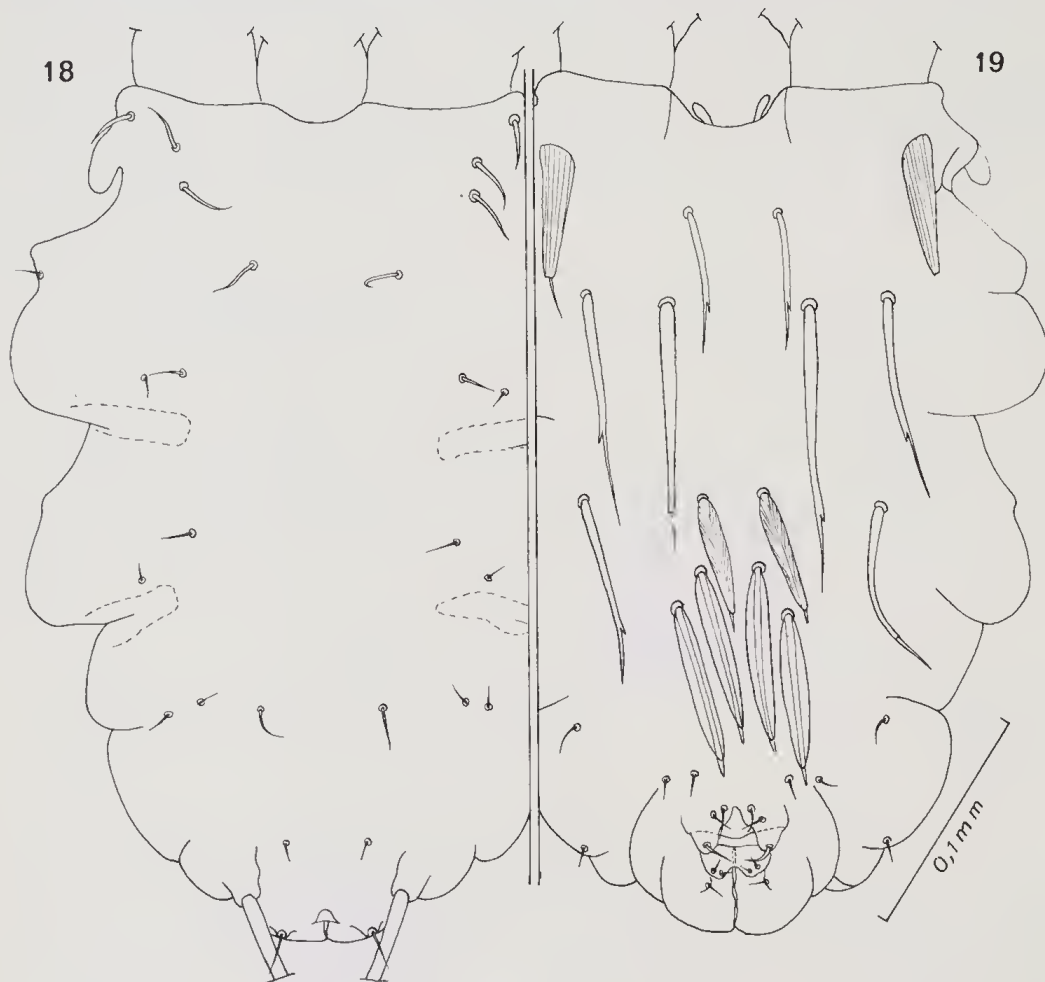
Figs 16-17: *Radfordia (Syconcterobia) vesca* sp.n. Holotype female. Fig. 16 - ventrally; Fig. 17 - dorsally.

### 3. *Radfordia (Radfordia) australiana* sp.nov.

This species is close to *R.(R.) ensifera*, however it is distinguished from it in the female by the greater length of the *l 1* setae ( $80\mu$ , for  $45\mu$  in a specimen of *R. ensifera* from *Rattus norvegicus*), the smaller length of the *ic 4* setae ( $18\mu$ , instead of  $30\mu$  in *ensifera*). In the tritonymph the setae *sc e*, *sc i*, *d 1*, *d 2*, *l 1*, *l 2*, *l 3* are membraneous and much wider and more asymmetrical than in *R. ensifera*, and the *v i* are longer ( $80\mu$ , for  $30\mu$  in *ensifera*).

**Female (Figs 18-19):** Holotype 390 $\mu$  long and 259 $\mu$  wide. **Dorsum:** *v i* setae rodlike and toothed, 60 $\mu$  long; *sc i* setae longer (120 $\mu$ ) than *sc e* (88 $\mu$ ); *l 1* setae 80 $\mu$  long; *d 1* lanceolate-foliate 57 $\mu$  long and 9 $\mu$  wide; the *d 2* and *l 2* are 80 $\mu$  and 75 $\mu$  long and 10-11 $\mu$  wide. Genital lobes poorly developed. **Venter:** coxal setae 3-2-1-2. The *ic 1* relatively thick and 21 $\mu$  long, the *ic 4* narrower and 18 $\mu$  long; the *ic 2* and *ic 3* much thinner and 12-15 $\mu$  long. Legs II-IV with rather long setae and without true spines, except at the anteroventral seta of tibia II distinctly spinous.

**Male (Figs 14-15):** Allotype 310 $\mu$  long and 198 $\mu$  wide. **Dorsum:** genital orifice at 25-30 $\mu$  behind the level of *sc e* setae. The *v i* are very thin, the *sc i* are thicker and 27 $\mu$  long, both are toothless. Penis 90 $\mu$  long. There are 3 pairs of thin setae in the genital area. The paramedian pair in the posterior region of the dorsum is 42 $\mu$  long. **Venter:** as in the female.



**Figs 18-19:** *Radfordia (Radfordia) australiana* sp.n. Holotype female. **Fig. 18** - ventrally; **Fig. 19** - dorsally.

**Tritonymph:** Body  $260\mu$  long,  $255\mu$  wide. Legs I symmetrical. Tarsi II and III with one claw, tarsus IV without a claw but bearing 5 unequal setae: one strong bifid rod, one smaller spinous setae, one foliate, one very thin and one very small. **Dorsum:** the *sc i*, *sc e*, *d 1*, *d 2*, *l 1*, *l 2* and *l 3* setae are broad, membraneous and strongly asymmetrical. The *ve* are very small; the *vi*, situated between the *sc i*, are membraneous,  $80\mu$  long, narrow and only slightly asymmetrical.

**Deutonymph:** With only the legs I-II and III. Dorsal setae as in tritonymph but smaller.

**Venter:** the *ic 1* to *ic 4* are present.

**Protonymph:** As deutonymph but the *ic 4* are lacking.

#### **Host and locality**

On *Rattus tunneyi* Thomas, 1904, Mount Hart, 10.IX.1976, (rat n° 2681) (holotype and 7 paratypes females, allotype and 8 paratypes males; 25 paratypes nymphs).

## **ACKNOWLEDGEMENTS**

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## ECTOPARASITES OF WESTERN AUSTRALIA SPINTURNICID MITES FROM BATS<sup>1</sup>

R. DOMROW\*

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### ABSTRACT

Four species of spinturnicid mites are listed from bats from the Kimberley, Western Australia: *Spinturnix novaehollandiae* Hirst from *Chalinolobus gouldii* (Gray) (Vespertilionidae); *S. eptesici* Domrow principally from *Eptesicus pumilus* (Gray) and *E. douglasi* Kitchener (Vespertilionidae); *Meristaspis calcarata* (Hirst) from *Pteropus scapulatus* Peters and *P. alecto* Temminck (Pteropodidae); and *M. macroglossi* (Hirst) from *Macroglossus lagochilus* Matschie (Pteropodidae).

### INTRODUCTION

This contribution to the ectoparasites of Western Australia collected by Dr F.S. Lukoschus, Catholic University, Nijmegen, concerns the Spinturnicidae, a compact family of mesostigmatic mites peculiar to bats. The fauna of Australia, New Guinea and, incidentally, the Orient was reviewed by Domrow (1972), with additions by Domrow & Nadchatram (1978). Tenorio (1976) listed the type material in the Bernice P. Bishop Museum, Honolulu. As only one species — *Spinturnix novaehollandiae* Hirst — was recorded from Western Australia, I now list four, in two genera, from the Kimberley.

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Hosts are largely after Ride (1970). Depositories are abbreviated: WAM Western Australian Museum, Perth; FMNH Field Museum of Natural History, Chicago; QIMR Queensland Institute of Medical Research, Brisbane; CU Catholic University, Nijmegen.

### *SPINTURNIX NOVAEHOLLANDIAE* HIRST, 1931

Although this species was recorded by Domrow (1972) from all Australian vespertilionid genera except *Phoniscus* Miller, species of *Chalinolobus* Peters appear to be the principal hosts. It is the only species previously recorded from Western Australia, at Eucla in the extreme south-east, host *C. morio* (Gray).

Deutonymph (premale): Homomorphic. Too crinkled to illustrate profitably, but details (including those of capitulum and legs) as in ♀, except as follows. Idiosoma at least 780  $\mu\text{m}$  long, 605  $\mu\text{m}$  wide. Hysteronotal setae in narrow, essentially uninterrupted band of 10 pairs. Margin of sternal shield behind setae  $st_3$  triangular rather than transverse. Ventral cuticle with 16 setae between coxae III and four setae (arranged 2.2) between coxae IV.

#### Host and Locality

On Gould's wattled bat, *Chalinolobus gouldii* (Gray) (Vespertilionidae) (2616), Beagle Bay, 25.VIII.1976 (1 ♀, 1 dn). In WAM, FMNH.

### *SPINTURNIX EPTESICI* DOMROW, 1972

This species was described from the first host listed below. The specimens from the third and, certainly, the fourth hosts are best regarded as stragglers.

All the protonymphs are homomorphic and unsexable (Rudnick 1960). However, in line with the following paragraph, one protonymph enclosing a developing heteromorphic deutonymph would be prefemale, and another enclosing a developing homomorphic deutonymph premale.

Rudnick (1960) confirmed that the deutonymphs of *S. kolenatii* Oudemans [identified as *S. vespertilionis* (Linnaeus) by Oudemans (1903)] are sexually dimorphic — indeed, to the extent that the prefemale could be termed heteromorphic (in the simple sense of differing in *habitus* from all other stages). The only developing adult enclosed in a heteromorphic deutonymph is unfortunately too young to sex, only the claws of legs II-IV being clear, but it would be female. One homomorphic deutonymph predictably encloses a developing male and another an adult so young that only the claws of legs II-IV are clear.



Fig. 1: *Spinturnix eptesici* Domrow. Heteromorphic (prefemale) deutonymph. Dorsum of idiosoma. Photo by Miss Robyn Wilson.



In agreement with Rudnick's (1960) statement that birth is given to the protonymph, the latest stage seen enclosed within the female was the protonymph, sometimes itself developing within a larva. What happens to the egg shell and larval pelt is uncertain; perhaps they are absorbed, perhaps expelled in some manner, cf. genus *Glossina* Guenée (Diptera: Muscidae) (Gordon & Lavoipierre 1972).

Protonymph: Homomorphic. Capitulum holotrichous [using *S. myoti* Kolenati as basis for comparison, see Evans (1968)]; similar in outline to that of the adult of its own species. Idiosoma 650-750  $\mu\text{m}$  long, 530-630  $\mu\text{m}$  wide (larger specimens enclosing developing deutonymph). Dorsum as in *S. myoti*, except as follows. Two most widely set pairs of setae on anterior portion of dorsal shield tending more to be on shield. Hysteronotal setae comprising one pair immediately behind stigmata and two terminal pairs. Venter as in *S. myoti*, except as follows. Genital setae (i.e. first pair of setae preceding pair of accessory genital shieldlets in later stages) absent. Ventral cuticle with four setae between coxae III and two (occasionally one) setae between coxae IV.

Deutonymph (prefemale) (Fig. 1): Markedly heteromorphic. Details (including those of capitulum and legs) as in ♀, except as follows. Idiosoma probably normally well within following limits: 825  $\mu\text{m}$  long, 715  $\mu\text{m}$  wide (slightly ruptured), 660  $\mu\text{m}$  long, 550  $\mu\text{m}$  wide (crinkled). Dorsal shield ovate, 460  $\mu\text{m}$  long, 285  $\mu\text{m}$  wide, with all eight pairs of setae very elongate (cf. second phenon of *S. loricata* Domrow, 1972), any seta being at least twice as long as longitudinal interval between it and next seta; surface with heavy areolations possibly representing muscle insertions. Four dorsal glands opening submarginally onto dorsal shield. Hysteronotal setae in about 26 pairs, very elongate and crowded around posterior margin of dorsal shield, but less so terminally. Sternal shield with setae  $st_{1-3}$  set submarginally, and margin behind  $st_3$  triangular rather than transverse. Ventral cuticle with nine to 10 setae between coxae III and two to four setae between coxae IV.

Deutonymph (premale): Homomorphic. Too similar to ♀ to illustrate profitably, and details (including those of capitulum and legs) as in ♀, except as follows. Idiosoma either ruptured or crinkled, but probably about 715  $\mu\text{m}$  long, 530  $\mu\text{m}$  wide. Four dorsal glands opening submarginally onto dorsal shield. Hysteronotal setae in narrow, essentially uninterrupted band of about 10 pairs (range 8.9 to 10.12). Sternal shield with setae  $st_{1-3}$  set submarginally, and margin behind  $st_3$  triangular rather than transverse. Ventral cuticle with four (occasionally five) setae between coxae III and two (occasionally one) setae between coxae IV. In one specimen, tarsus IV on

one side and tibia-tarsus IV on other are mere stumps, with correspondingly reduced setation and no ambulacra.

#### Hosts and Localities

On little bat, *Eptesicus pumilus* (Gray) (Vespertilionidae) (2643), Napier Downs, 1.IX.1976 (1 ♀). On *E. pumilus* (2756), Beverley Springs, 20.IX.1976 (1 ♀). On *E. pumilus* (3076), Mitchell Plateau, 23.X.1976 (3 ♀♀, 4 ♂♂, 1 dn). In WAM, FMNH, QIMR, CU.

On bat, *Eptesicus douglasi* Kitchener (2745), Beverley Springs, 20.IX.1976 (3 ♀♀, 1 ♂, 2 pn). On *E. douglasi* (2831), Brooking Springs, 29.IX.1976 (1 ♀, 2 ♂♂, 1 dn, 1 pn). On *E. douglasi* (2846, 2848, 2895, 2900, 2911, 2914, 2915, 2916, 2926, 2929, 2964, 2980), Geikie Gorge, 30.IX, 3, 4, 5, 8, 9.X.1976 (13 ♀♀, 11 ♂♂, 5 dn, 5 pn). In WAM, FMNH, QIMR, CU.

On Arnhem Land long-eared bat, *Nyctophilus arnhemensis* Johnson (Vespertilionidae) (2756), Beverley Springs, 20.IX.1976 (1 ♀, 1 pn). In WAM, FMNH.

On common sheath-tailed bat, *Taphozous georgianus* Thomas (Emballonuridae) (2658), Napier Downs, 2.IX.1976 (1 ♀). In WAM.

#### MERISTASPIS CALCARATA (HIRST, 1923)

This parasite has species of *Pteropus* Brisson as its principal hosts (Malagasy, Oriental and Australian Regions).

Deutonymph (prefemale): Slightly heteromorphic. Too similar to ♂ to illustrate profitably, and details (including those of capitulum and legs) as in ♂ except as follows. First pair of proteronotal setae set in anterior angles of transverse rectangular shield convenient to truncated anterior margin of dorsal shield and of a size equal to that of tritosternum. Dorsal cuticle with one pair of postscutal setae in addition to two pairs of terminal (dorsocaudal) setae as in adult (Wilson 1967, Domrow 1972); not spinulose terminally. Tritosternum slightly convex posteriorly.

Deutonymph (premale): Homomorphic. Too similar to ♂ to illustrate profitably, and details (including those of capitulum and legs) as in ♂, except as follows. Dorsal cuticle not spinulose terminally. Tritosternum slightly convex posteriorly.

#### Hosts and Localities

On red flying fox, *Pteropus scapulatus* Peters (Pteropodidae) (2632, 2633, 2634), Napier Downs, 31.VIII.1976 (6 ♀♀, 4 ♂♂, 3 dn). On *P. scapulatus*



(2820, 2876), Brooking Springs, 29.IX, 1.X.1976 (1 ♀, 1 dn). In WAM, FMNH, QIMR, CU.

On black flying fox, *Pteropus alecto* Temminck (2819, 2877, 2962), Brooking Springs, 28.IX, 2, 7.X.1976 (10 ♀♀, 3 ♂♂, 2 dn). On *P. alecto* (2969), Geikie Gorge, 8.X.1976 (1 ♀). In WAM, FMNH, QIMR, CU.

### MERISTASPIS MACROGLOSSI (HIRST, 1923)

This species occurs on pteropodid genera other than *Pteropus* (Oriental and Australian Regions).

Male: Homomorphic. As described by Prasad (1969) under name *M. dusbabeki* Baker & Delfinado, with one exception: hair-like setae on idiosoma in same number (17 pairs) and arrangement as described by Wilson (1967) for *M. calcarata*.<sup>2</sup>

#### Host and Locality

On northern blossom bat, *Macroglossus lagochilus* Matschie (Pteropodidae) (3002, 3013, 3017, 3020, 3022, 3023, 3042), Mitchell Plateau, 17, 19, 20.X.1976 (13 ♀♀, 4 ♂♂). In WAM, FMNH, QIMR, CU.

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<sup>2</sup> Prasad mentioned 'three pairs of setae on integument between coxae IV and the anal shield', but illustrated only two pairs in this region, which is the first to be obscured by excretory granules; while the terminal setae are uniformly 2.2 in my four specimens, they are certainly variable in *M. calcarata*, being 2.2 in five of the seven specimens listed above, 2.1 in one and 1.1 in one.

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## FLEAS (SIPHONAPTERA) FROM SOME WESTERN AUSTRALIAN MAMMALS

F.G.A.M. SMIT\*

[Received 24 November 1977. Accepted 23 February 1978. Published 5 June 1979.]

### INTRODUCTION

As a member of the 'Kimberley District Expedition of the Field Museum of Natural History, Chicago', Dr F.S. Lukoschus was able to examine 508 mammals for ectoparasites (with emphasis on mites) in north Western Australia for about three months in 1976. Thus 24 fleas were collected from echidnas and 40 from a species of bat. These fleas belong to the following two species.

#### *ECHIDNOPHAGA LIOPUS* JORDAN & ROTHSCILD, 1906

8 ♂, 15 ♀, Napier Downs (a homestead at 17°15'S, 124°44'E), from *Tachyglossus aculeatus* (Shaw), 5.IX.1976.

1 ♀, Mitchell Plateau, from *Dasyurus hallucatus* Gould, 22.X.1976.

This species was only known from the type series (24 ♂, 66 ♀) collected by C.J. Tunney on Mount Anderson (18°01'S, 123°56'E), Western Australia, from *Tachyglossus aculeatus* in November 1901. The two females supposedly from Agra (27°10'N, 78°00'E), India (from rats, II.1904, leg. Captain Windsor), as listed in the original description, are doubtless mislabelled specimens. It is inconceivable that this flea, with a very restricted distribution in Australia, would also occur in central northern India on rats (whereas it appears to be specific to the echidna). Hopkins & Rothschild (1953: 78, footnote) made the suggestion that, 'This Australian species was presumably accidentally introduced into India by man, possibly with horses, which at one time were imported on a large scale.' This would seem to be a rather far-fetched explanation.

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\* British Museum (Natural History), London.

*Echidnophaga liopus* is easily distinguishable from the eleven other representatives of the genus occurring in Australia by the greatly reduced chaetotaxy of the distitarsomeres, there being normally only one basal pair of stout lateral setae and, on the apical half, only two pairs of short and very thin lateral setae (apart from the normal apico-lateral pair of long slender setae and the pair of stout apical plantar setae). It must be noted, though, that occasionally (in about 10% of the specimens examined) a distitarsomere may deviate from that setal pattern and in both the type series and the material collected by Dr Lukoschus a hind distitarsomere may have one or both setae of the second lateral pair much thickened, attaining the stoutness of the setae of the basal pair; they may also be somewhat displaced and sometimes an extra thin lateral seta is present. Such setal abnormalities are very rare in the mid distitarsomere while I have not seen any unusual fore distitarsomeres.

#### *LAGAROPSYLLA MERA* JORDAN & ROTHCHILD, 1921

11 ♂, 20 ♀, Mount Hart (16°55'S, 125°05'E), from *Tadarida jobensis* (Miller), 10-18.IX.1976.

4 ♂, 5 ♀, Beverley Springs (16°35'S, 125°29'E), same host, 18-22.IX.1976.

Quite a common flea of various species of *Tadarida* in Australia, Java, Malaya and the Philippines. In Australia (apart from Western Australia also known from the Northern Territory and Queensland; see Dunnet & Mardon 1974: 124) presumably mainly associated with *Tadarida jobensis*.

#### ACKNOWLEDGEMENTS

This paper results from the combined Western Australia Field Programme between the Field Museum of Natural History, Chicago, and the Western Australian Museum, Perth. The participation of a mammal group was made possible by the generous gift of Mr William S. and Mrs Janice Street, Ono, Washington, and the aid of grant R 87-111 by the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

Deposition of specimens: Western Australian Museum, Perth; Field Museum of Natural History, Chicago; British Museum (Natural History), London; Department of Zoology, Nijmegen.

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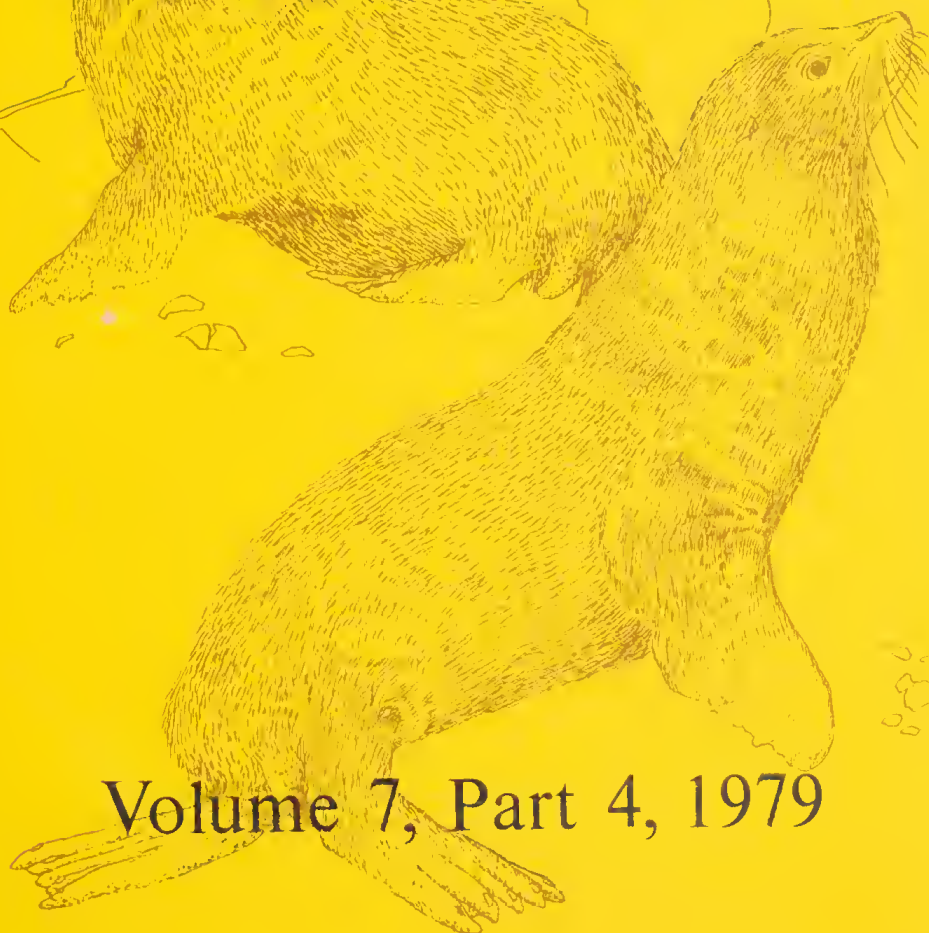
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# RECORDS OF THE WESTERN AUSTRALIAN MUSEUM



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Cover: Australian sea lion (*Neophoca cinerea*), drawn by Gaye Roberts.  
This species still occurs in Western Australia on offshore islands  
from Shark Bay to the Recherche Archipelago.

ISSN 0312-3162

## **33,000 YEAR OLD STONE AND BONE ARTIFACTS FROM DEVIL'S LAIR, WESTERN AUSTRALIA**

C.E. DORTCH\*

[Received 29 March 1978. Accepted 30 May 1978. Published 16 July 1979.]

### **ABSTRACT**

A lower, largely re-worked zone of the cave deposit at Devil's Lair, Western Australia, radiocarbon dated about 33,000 BP, contains very sparse archaeological assemblages consisting of flakes and other artifacts, including some apparent tools, made of calcrete; a few artifacts of quartz and other stone; and at least three bone artifacts. These assemblages and other small finds of definite or possible archaeological significance are described, and various natural sources of stone and bone fracture within the cave which may have produced pseudo artifacts are assessed. Carbonate encrusted stone and bone artifacts, including two encrusted probable artifacts of bone, both of which may be made on bones of extinct macropodines, are tentatively regarded as re-deposited from an older part of the cave deposit, evidence which may mean that human occupation of this part of southwestern Australia substantially predates 33,000 BP.

The scarcity of artifacts and the absence of occupational features in the lower part of the deposit suggest that people seldom or never entered the cave before 27,700 BP, the radiocarbon age of the oldest known Devil's Lair occupation feature. All artifacts stratigraphically below this feature could have washed or fallen into the cave from occupation sites immediately outside.

### **INTRODUCTION**

In 1976 and 1977 staff of the Western Australian Museum and others engaged in the sixth and seventh seasons of excavation in the archaeological and palaeontological investigations which since 1970 have been centred on the cave of Devil's Lair (30°9'S. 115°4'E). These two seasons' excavations were directed principally

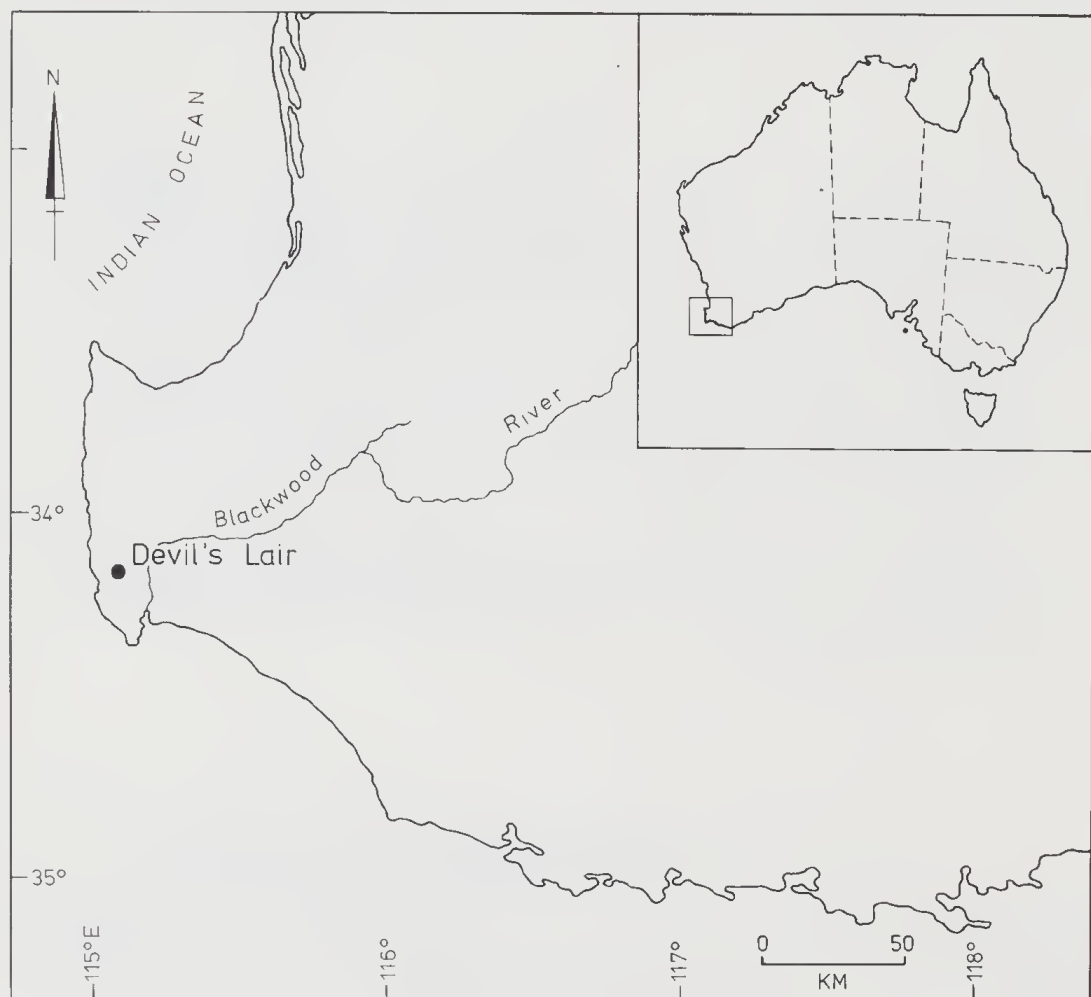
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\*Archaeology Department, W.A. Museum, Francis Street, Perth, W.A. 6000.



towards the deepening of the eastern end of the main excavation with the purpose of recovering, within the stratigraphical controls developed (Balme, Merrilees and Porter in press; Baynes, Merrilees and Porter 1975; Dortch 1974; 1976; Dortch and Merrilees 1973), faunal and artifact assemblages and also sediment, radiocarbon, pollen and other samples which can provide data for assessing significant aspects of late Pleistocene prehistory in this part of south-western Western Australia (**Fig. 1**).

During the 1976 season the field team concentrated on the excavation of layers 29-38 in Trenches 2, 7c, 7d, 8<sub>2</sub>, 8<sub>1</sub>, and 9 (**Figs 2-5**), a part of the deposit containing the oldest archaeological material known from Devil's Lair. The 1977 season was basically a test excavation aimed at reaching the bottom of the cave deposit; and



**Fig. 1.** South western Australia showing the location of Devil's Lair.

during this season layers 39-51 were delineated. Trench 10 (Fig. 2) was opened during 1977 to provide greater working space and a larger sample of material from the lower layers.

The following paper evaluates the rock and bone fracturing capabilities of various natural phenomena in Devil's Lair, and describes a number of stone and bone artifacts, some probable artifacts, and several other small finds of definite or possible archaeological significance which have been identified in layers 29-38.

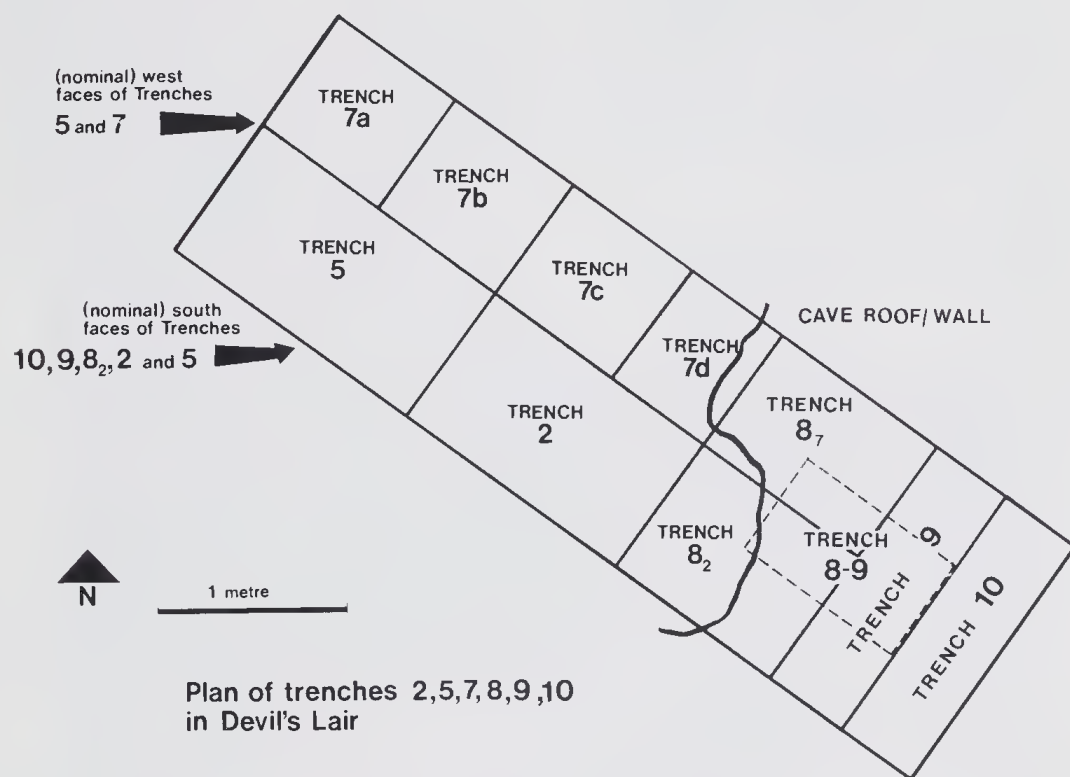


Fig. 2. Plan of main excavation, Devil's Lair (see Fig. 6).

## STRATIGRAPHY

Previous publications (Baynes, Merrilees and Porter 1975; Dortch 1974; Dortch and Merrilees 1973; Shackley 1978) have described the sandy Devil's Lair floor deposit as consisting essentially of lightly cemented sand lenses and laminae interspersed with lithified sandy bands, crystalline bands of calcite (flowstone), stalagmitic masses and limestone fragments of different origin and composition, ranging in size from silt through boulder grades.

Most layers in the deposit contain very large quantities of animal bones, some of which are debris resulting from human food preparation and meals; and many layers contain small numbers of stone and bone artifacts. Charcoal fragments occur in abundance in parts of the deposit, and above layer 29 several concentrations of charcoal and archaeological material, some containing fire-crazed quartz grains and patches of scorched sand, seem to be hearths (cf. Shackley 1978, p.38). However much of the charcoal scattered throughout the deposit may have washed or fallen in.

Dortch and Merrilees (1973) theorised that the entrance to Devil's Lair is relatively very recent and that a former entrance is located at the top of a cone or fan of sediments in the present rear of the cave (**Fig. 6**). The slope of the bands or laminae visible in the walls of the excavation shows that most of the sediments are derived from the former entrance, the most notable exception being the uppermost layer A (**Figs 3,5**) which is a fan of dark brown sediment sloping through the present entrance. One of the Devil's Lair radiocarbon dates (SUA 342:320  $\pm$  85 BP: **Fig. 5**) shows that layer A entered the cave very recently, apparently when formation of the present doline outside Devil's Lair created the present entrance.

The nature and size of the probable former entrance have not been established though at times it must have been large enough to have allowed human beings to enter the cave. Evidence for human occupation within Devil's Lair is provided by the hearths noted above and by the presence of several pits, notably Pit 2 (Baynes, Merrilees and Porter 1975; Dortch and Merrilees 1973); and by an occupation surface near the top of the deposit (Dortch 1974). There are no occupational features below layer 28 (**Figs 3-5**), a charcoal-rich band containing numbers of animal bones and artifacts. This is a hearth zone tentatively interpreted as containing the remains of various episodes of occupation scattered by people or animals, erosion, or a combination of these, and apparently compressed following burial.

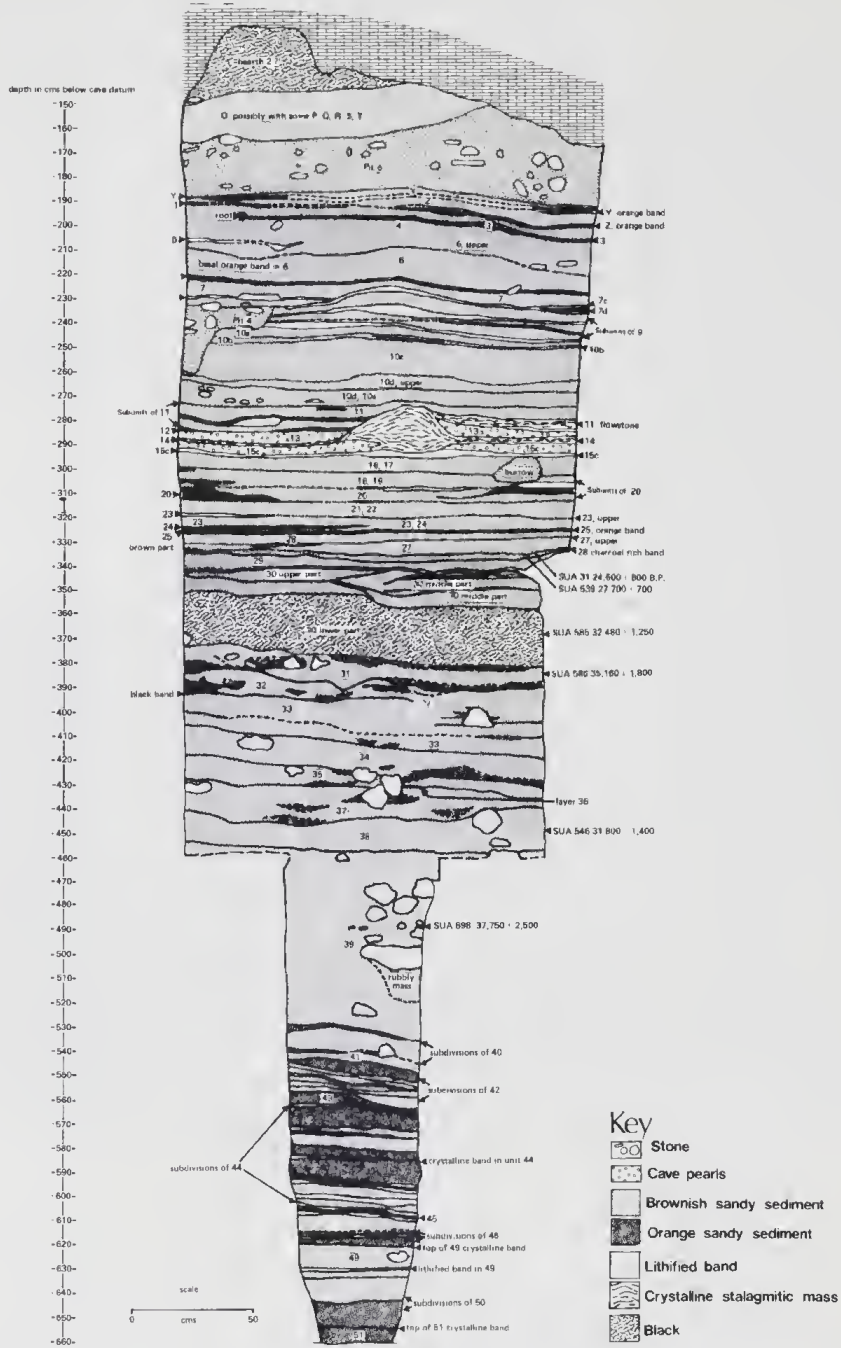
Layers 29-51, including their various sub-units, are a series of sandy lenses which in the confines of the excavation appear as a succession of broad layers and relatively much thinner bands and laminae. In layer 44 and below some of the sandy units are interspersed with crystalline bands or lenses and bands of sand indurated with carbonate cement (**Fig. 4**).

In layers 31-38, and to some extent 29 and 30, there are numerous clearly defined cut and fill structures including channels ogival in section with steeply sloping sides two to 15 cm apart and up to eight cm deep; and multiple, partly superimposed channels showing complex convoluted or angular section contours. Most of these channels can be clearly seen because they are filled with well sorted large, orange quartz grains, sediments which in the context of Devil's Lair are suggestive of deposition by relatively high energy water flow.





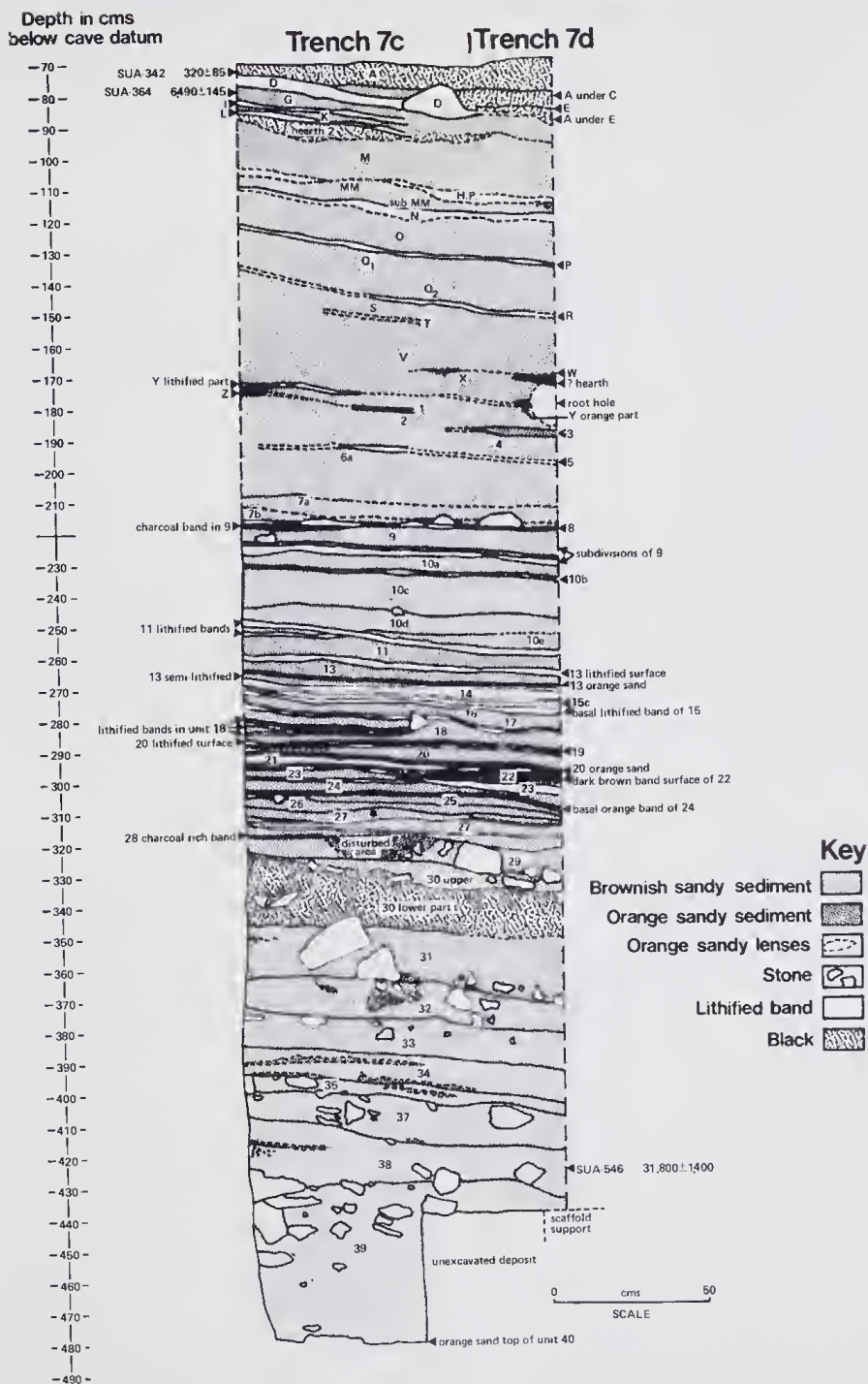
DEVIL'S LAIR, TRENCH 9  
Nominal East face



**Fig. 4.** Nominal east face of Trench 9, Devil's Lair, showing Test Trench 8-9 extending two metres below layer 38 (see Fig. 2).



# Devil's Lair Trench 7c Nominal north face



Despite the extensive erosion which has occurred here the depositional sequence of layers 31-38 is largely preserved; and in most parts of the trenches it was possible to remove much of each layer without mixing from adjacent units above or below, or from channel fillings. Relatively large amounts of sometimes massive limestone rubble, mostly weathered sub-rounded to sub-angular fragments typical of entrance debris, were recovered from layers 31-38; and most of this rubble probably derives from the former entrance.

Also in layers 29-51, particularly in layers 31-38, there is an important and distinctive series of carbonate encrusted stones and bones. Although many other bones and limestone fragments from various parts of the cave deposit are encrusted with carbonate cement of varying colours and textures, the encrusted group here seems distinctive, not only because of the appearance of the encrustations – a fine brown carbonate cement very thickly studded with large iron-stained quartz grains, but also because the series seems a characteristic component only below layer 28.

The evident concentration of encrusted stones and bones in layers 31-38 may mean that they were washed in during the episodes of exceptional erosion occurring intermittently with the aggradation of these layers. Since these layers also contain many stones and bones entirely without encrustations it is suggested that the encrusted series derives from a part of the deposit at least marginally older than layers 31-38. The presence of similar carbonate encrusted bones in layers 39-51 suggests that the series in layers 31-38 may derive from a part of the cave deposit near the entrance which is perhaps wholly or in part contemporaneous with layers 39-51. Also possibly indicative of relatively advanced age for the encrusted series is the presence in it of a number of bones pertaining to totally extinct marsupial species, taxa which in layers 30 and below are only very poorly represented among the bones without encrustations (Balme, Merrilees and Porter *in press*, Table 8). Samples of encrusted and unencrusted bones from layers 31-38 are due to be analysed chemically in an attempt to determine whether there are significant differences in their ages, as was recently done by Milham and Thompson (1976) with bone assemblages at Madura Cave in the Nullabor Plain.

Layer 30 (Figs 3-5) resembles layer A in colour, texture and structure, i.e. it consists of thick bands of dark brown to black earthy sediment intercalated with thinner bands or laminae of fine textured compacted material. It is suggested that layer 30, like layer A, is part of a fan of earth which slumped relatively quickly into the cave, in this case with the possible sudden widening of the former entrance (Fig. 6). If so, it may be that the absence of occupational features in layers 31-38, assuming that they were not totally destroyed by erosion, reflects a period when the former entrance was too small for human entry. Layer 30 seems then to mark a turning point in the cave's history. Above it there is, as noted above, good evidence for in-

intermittent human occupation, and there are relatively numerous artifacts (Dortch and Merrilees 1973, Tables 2,3), whereas artifacts are extremely sparse in layers 30-38, and absent in layers 39-51. These lower layers may represent a time when the cave was never or rarely occupied by human beings and artifacts washed or fell into the cave only very occasionally from occupation sites in the vicinity of the former entrance.

### RADIOCARBON AGE OF LAYERS 28-51

Radiocarbon dates obtained from charcoal samples collected from layers 18 to 39 are listed in **Table 1**; and stratigraphical positions of all dated samples in the Devil's Lair main excavation are shown in **Figs 3-5**.

**Table 1**

Radiocarbon dates from layers 18 to 39, Devil's Lair, Western Australia (cf. **Figs 3-5**)

Reference Number	Radiocarbon date (in years B.P.)	Layer or feature	Depth below Cave Datum (in cm)	Trench
SUA 457	31,400 $\pm$ 1500	Hearth in 18	293-302	8 <sub>7</sub> ,9
SUA 31	24,600 $\pm$ 800	28 (Hearth)	c. 340	2
SUA 539	27,700 $\pm$ 700	28 (Hearth)	c. 340	8 <sub>2</sub> ,8 <sub>7</sub>
SUA 585	32,480 $\pm$ 1250	30, lower part	c. 350	2,8 <sub>2</sub> ,9
SUA 586	35,160 $\pm$ 1800	31	c. 375	2,7d,8 <sub>2</sub> ,9
SUA 546	31,800 $\pm$ 1400	38	438-460	8 <sub>2</sub> ,8 <sub>7</sub> ,9
SUA 698	37,750 $\pm$ 2500	39	483-496	8 <sub>2</sub> ,8 <sub>7</sub> ,9

With the exceptions of SUA 457 and SUA 539 all radiocarbon dates in the series from layers A to 28 have been appraised in previous descriptions of the Devil's Lair dating sequence (Baynes, Merrilees and Porter 1975; Dortch 1974; 1976; Dortch and Merrilees 1973). The discrepant date SUA 457 is unresolved in this interpretation of the dating sequence. Further radiocarbon assessment now underway may provide a more reliable age for this part of the deposit and also for unit 28, now dated by the statistically dissimilar SUA 31 and SUA 539. However this charcoal band, the stratigraphically lowermost and oldest human occupational feature known in the cave, is provisionally assumed to be as old as 27,700  $\pm$  700 BP (SUA 539), since it is possible, as noted earlier, that it has a composite origin and contains compacted charcoal of more than one hearth resulting from intermittent occupation over a long period.

Regarding layers 29-51, Dr R. Gillespie, Sydney University Radiocarbon Laboratory, has advised to refer to the statistically similar dates SUA 585, SUA 586 and SUA 546 by their "mean pooled age". The radiocarbon ages in years BP of these lower layers is as follows.

layer 29 - c. 29,500 (age estimated by interpolation)

layers 30 to 38 -  $32,800 \pm 830$  ("mean pooled age": R. Gillespie, pers. comm.)

layer 39 - c.  $37,750 \pm 2500$

layers 40 to 51 -  $>37,750$

The three statistically similar radiocarbon dates between layers 30 and 38 suggest that the high energy mode of deposition which accounts for at least part of these layers' accumulation took place over a relatively short period of time, compared with the slower rate of deposition implied by radiocarbon dates from the upper part of the deposit.

### LIMESTONE FRAGMENTS AND SOURCES OF FRACTURE

There are three main forms of limestone found in and around Devil's Lair. The first of these, aeolian calcarenite or "aeolianite", is a chief component of the Quaternary Coastal Limestone of south-western Australia (Lowry 1967; McArthur and Bettenay 1960). This stone consists essentially of calcareous particles and quartz grains cemented by calcium carbonate (cf. Shackley 1978, p.33); it is often very friable in fresh exposures though it becomes hardened with exposure. When flaked aeolianite shows uneven fracture, described in Dana as "rough and entirely irregular" (Ford 1958, p.214). Calcrete is a secondarily carbonate-enriched limestone which often forms a thick caprock developed within some sandy soils of the Coastal Limestone, as locally in the Deepdene Soil Association (Smith 1951). Calcrete and strongly cemented aeolianite are the dominant rocks exposed in outcrops and dolines in the neighbourhood of Devil's Lair.

The calcrete is tough and sometimes very fine textured, though often containing small amounts of quartz grains. Fragments and nodules of this stone can be flaked as easily as chert, producing sharp-edged flakes with durable cutting edges. Calcrete shows conchoidal, sub-conchoidal or even fracture, depending on its degree of consolidation and textural fineness, and to some extent on the nature of the fracture source (see below). Even fracture is flat or slightly curving and shows none of the definitive features of conchoidal fracture. Sub-conchoidal fracture refers to positive or negative flake scars lacking some of the distinctive features of conchoidal fracture (cf. Ford 1958, pp.213-14; Oakley 1965, Fig. 4).

The two flakes in Fig. 7 were experimentally struck from calcrete nodules by direct percussion with a calcrete hammerstone. Each flake has sub-conchoidal fractures characterised by diffuse bulbs of percussion (negative and positive), and extensive, faint fissures; bulbar scars and ripples are absent. Most Devil's Lair calcrete artifacts have sub-conchoidal fractures similar to these produced experimentally; well developed conchoidal fractures are rare.

Another form of limestone found within Devil's Lair consists of calcite



speleothems, notably stalactites, stalagmites and flowstone (the latter is labelled “lithified bands” in **Figs 3-5**). In Dana (Ford 1958, p.513) it is noted that calcite shows conchoidal fracture, though “obtained with difficulty”; instead this stone tends to break along lines of cleavage. Numbers of fragmentary calcite crystals are also present in the cave deposit; although some of these resemble artifacts it has not been possible to make any positive identifications.

Fragments (clasts) of aeolianite and calcrete found in the cave deposit with some exceptions derive from collapse or breakdown of the walls and roof of the cave; or they have washed or fallen into the cave from outside. Pieces of speleothems, not including the flowstones and stalagmites developed within the cave deposit, have also fallen from the cave’s ceiling and walls; or they may have been fractured and transported by collapse and erosion. Human and possibly animal activities account for some fracturing of all three forms of limestone within the cave.

The fracture surfaces on most of the limestone fragments from the deposit are generalised breaks probably resulting from mechanical adjustment of the cave roof and walls, and of limestone features outside the former entrance. In addition to clearly identifiable limestone artifacts the deposit contains *simple* flaked pieces, i.e. fragments with one or two negative flake scars (conchoidal, sub-conchoidal or even fractures), and *simple* flakes and chips which may be artifacts, or perhaps have been flaked naturally through rockfall. (Here and below *simple* flakes and chips are ones whose dorsal faces and butts are natural surfaces.)

Special attention is given here to the differences between artificially and naturally flaked limestone fragments as found in the Devil’s Lair deposit. The problem is fundamental since throughout most of the deposit there are naturally broken fragments, including both those produced by mechanical and by thermal fracture; and because over half of the artifacts in the very small assemblages below layer 29 are made of limestone. The first step in dealing with this problem is to review the possible or known sources of natural fracture, particularly percussion, in and around Devil’s Lair. The mechanical forms are deposit subsidence, erosion and rockfall; thermal fracture resulting from bush fires is the only form of non-mechanical fracture.

The first of these, subsidence of the cave deposit, does not seem to have caused pseudo-artificial stone chipping or flaking. This process could cause such fracturing if it involved high velocity movement of stones, or extreme shearing stresses within the deposit, though as yet there is no evidence that such subsidence has taken place in Devil’s Lair. While it is true that several thick stalagmitic columns resting on the present surface of the cave deposit are broken through horizontally, presumably through subsidence, in each case the gap between the fracture faces is very narrow, measuring 1-1.5cm, and indeed this suggests relative stability of the deposit. Stability is further suggested by the apparent absence of subsidence features within



the layered deposit exposed in the walls of the main excavation (**Figs 3-5**). Nor does sediment creep on the talus cone or fan below the probable former entrance or on the cave floor seem a likely source of stone fracture, considering these features' low gradients (cf. **Fig. 6**).

Unfortunately the degree or nature of erosional activity in and around the cave, and its capabilities for producing stone or bone fracture, cannot be fully evaluated until more is learned about the former entrance and the nature of the sediments buried below it. However the subdued relief and small size of the cave (**Fig. 6**), and most significantly the presence of many completely undamaged, very small and delicate bones in the channel – cut layers 31-38 seem to show that during these layers' deposition there was no erosion capable of significant fracturing and perhaps not even of extensive abrasion of stone or bone. This seems true even when taking into account the introduction, probably by erosion, of many large stones into this part of the deposit at this time.

Rockfall, the last potential source of natural percussion discussed here, warrants close consideration since it probably has produced some fracturing of stone and perhaps also bone in the Devil's Lair deposit. Fortunately it is possible to gain an idea of the percussion potential of rockfall experimentally by dropping limestone fragments on heaps of limestone rubble, in this way simulating rockfall situations as must have occurred at times in Devil's Lair. It is assumed that vertical distances within the present Devil's Lair chamber have never been greater than about six to nine m, including the drop between the probable former entrance and layers presumably buried below it which are contemporaneous with layers 29-51. This assumption seems warranted considering the proportions and size of the present cave chamber, and the relatively small size of the former entrance and its surrounding doline (**Fig. 6**).

In the rockfall experiments sub-round to angular limestone (calcrete and well lithified aeolianite) fragments selected from the Devil's Lair excavation spoil heap, and weighing 2-10 kg were dropped on rubble heaps of similar limestone fragments from vertical distances of 4-8 m. Optimum rock fracturing conditions existed in the experiments since no sand was present in the rubble heaps, as generally would have been the case in Devil's Lair.

The following observations are made from approximately 300 drops on different arrangements of limestone rubble.

1. Significant flaking, i.e. percussion producing flakes of maximum dimension < 4 cm, occurred only very infrequently, resulting in only three such flakes.
2. Very minor chipping (producing chips having maximum dimensions < 3 mm) was relatively frequent with more than 100 chips being produced. As many as four tiny chips could be produced by impact from a single falling rock.



Fig. 6. Cross section and plan of Devil's Lair (after Williamson, Loveday and Loveday, 1976).

3. All of the above flakes and chips are of the simple form defined above. All have very irregular, very thin or virtually non-existent butts; where present butts are natural surfaces, not fracture surfaces.

4. All flakes and chips have poorly defined sub-conchoidal fractures; in no case is the flake scar as well developed as on those flakes experimentally produced on some of the same nodules of stone by direct percussion with a hammerstone (e.g. **Fig. 7**).

Close observation of impact between limestone fragments in rockfall showed that it lacked the explosive quality of artificial percussion: either direct, or on an anvil in the bipolar method, or even by hurling stones downwardly against a rubble heap.

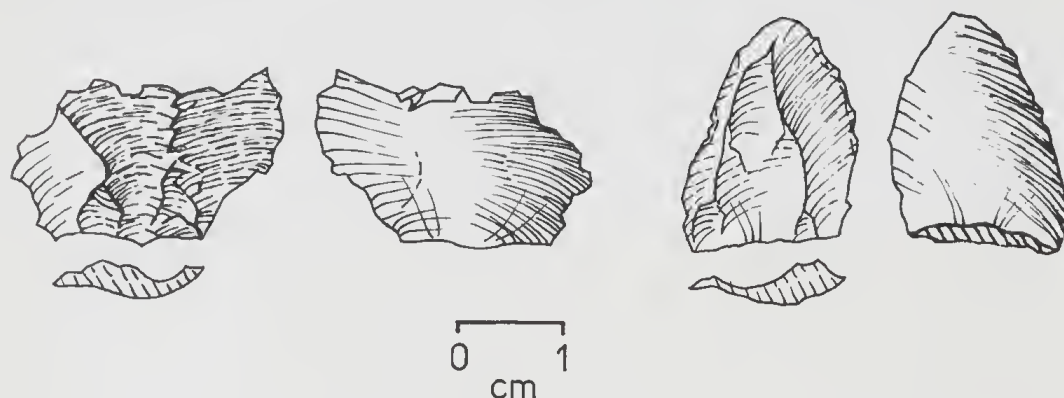


Fig. 7. Calcrete flakes produced by experimental direct percussion.

5. Rebound or tumbling did not cause fracturing of any consequence. Slopes of the rubble heaps in the experiments were much the same as those of various features in the cave, as shown in **Fig. 6**; it is concluded then that rebound was not a significant cause of natural fracture in Devil's Lair.

Following the above, a separate experiment was set up aimed at assessing the percussive potential of multiple rockfall against a single fixed edge. Different blocky pieces of fine grained calcrete selected as rockfall targets were successively wedged in the rubble heap in such a way that one angular portion of each piece presented a clear striking area. Multiple rockfall against these wedged fragments ranged between five and 100 drops. Impact almost always produced slight crushing or very minor shattering. However from one fragment three irregular chips, each with a single negative flake scar on its dorsal face, were produced by bombarding the same edge, though in varying positions, with fragments of stone, with total drops numbering about 50. The three chips produced did not closely resemble bona fide artifacts since they lacked the well pronounced conchoidal or sub-conchoidal fractures typically produced in stone knapping; because they lacked butts and merely had splintered edges at their proximal ends; and because they were entirely irregular.

Lengthier experiments may show that the flaking angles (i.e. the angle between the bulbar face and the butt or striking platform) of pseudo flakes are significantly different from those of bona fide flakes. Although untested it is conceivable that continued massive rockfall against a blocky fragment could produce multiple, adjacent and unidirectional flake scars resembling those on core flaking faces. Multiple rockfall on calcrete flakes wedged among rubble was also capable of producing fracturing resembling very irregular minor retouch or utilisation.

In summary the above experiments showed that the variables of stone weight, distance of fall, angle of contact on impact, and edge angles can at times combine in such a way that percussion by rockfall can result in the production of at least simple flakes and chips and corresponding pieces with negative flake scars. They also show that continued bombardment of rocks against a single exposed edge can, if only rarely, produce more complex chips and probably flakes, and also pseudo retouch and utilisation. I make the obvious conclusion then that rockfall cannot be discounted as a potential source of pseudo artifacts within and around Devil's Lair.

More exacting experiments assessing the flaking capabilities of rockfall do not seem warranted until more is learned about the size and shape of the former entrance, and so the probable nature of the rockfall which once took place there. Nevertheless it has been possible to identify limestone specimens listed in **Table 2** as flaked artifacts, and other specimens described later as probable artifacts (**Table 3**), not only in the light of the rockfall experiments, but also by means of technological criteria in the same way as in many other studies artifacts have been identified in scree slopes, fluvial gravels, cave fills and other deposits containing naturally fractured stones.

Most of the many apparently thermally fractured pieces from the cave deposit presumably derive from outside the cave. Such pieces, produced by bush fires, are very common at limestone outcrops in the area, and include sharp-edged specimens with flat or slightly curved faces resembling flakes, and blocky, sub-round to angular, faceted examples which are similar in appearance to flake cores. Some of these specimens from the Devil's Lair deposit superficially resemble flaked artifacts; however they can be distinguished from artifacts by their facets' lack of any of the features of conchoidal or other fracture resulting from percussion. For example the specimen in **Fig. 8:3** is a faceted, angular calcrete fragment probably produced by fire-induced thermal fracture, though it superficially resembles a bipolar core. (The piece was found in section cleaning, Trenches 7d, 8, and 9, layers 30-32.)

Thermal fractures can be produced simply by placing unbroken blocks or nodules of aeolianite or calcrete in an open wood fire, a few minutes' exposure to this heat being sufficient to cause the limestone to split and shatter. The aeolianite specimens in **Figs 9:1** and **9:2** are, respectively, flake-like and core-like pseudo artifacts



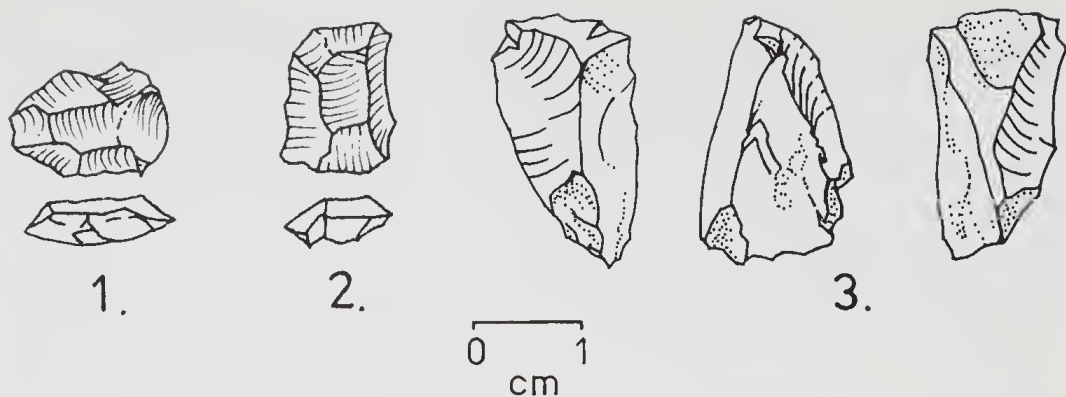


Fig. 8. Thermally fractured calcrete pseudo artifacts. Specimens 1 and 2 were experimentally produced; specimen 3 is from Devil's Lair.

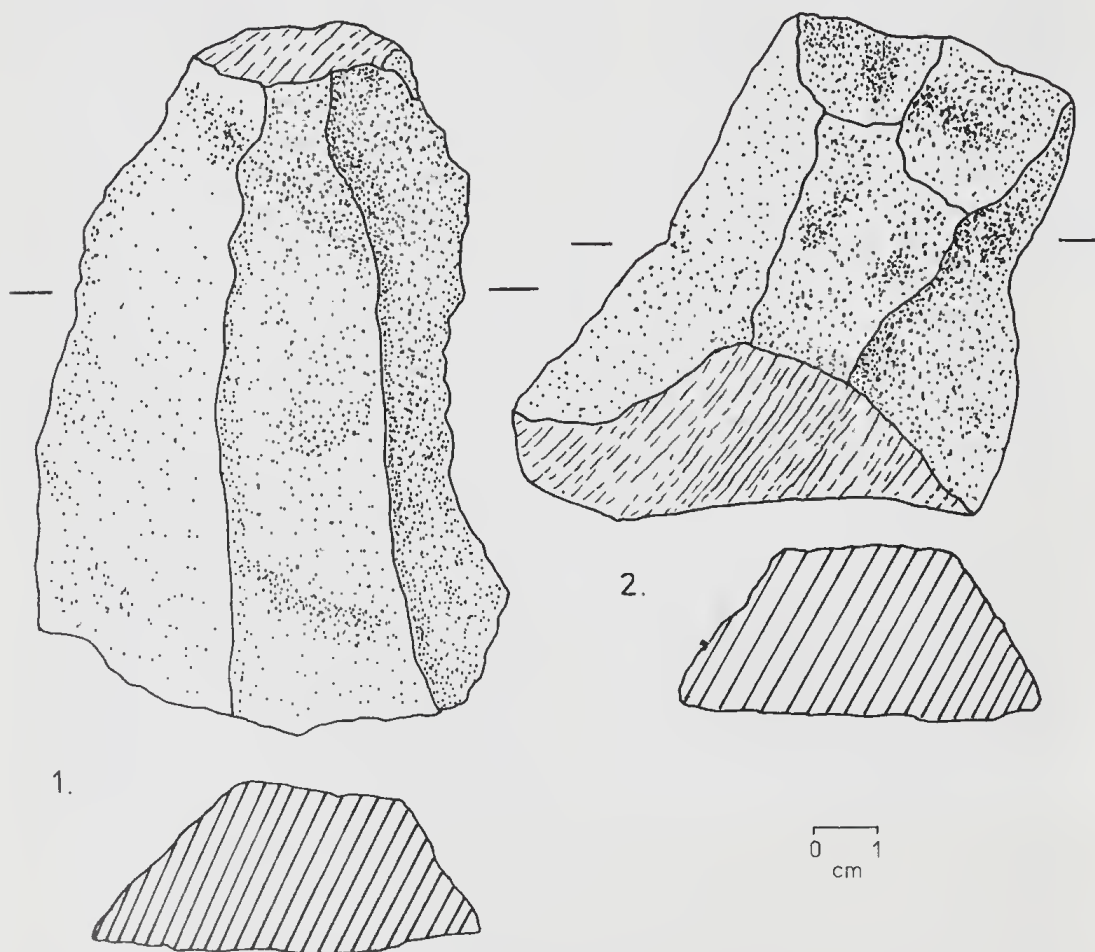


Fig. 9. Experimental thermally fractured aeolianite pseudo artifacts.



produced experimentally by placing limestone nodules in an open fire. These two pieces most closely resemble artifacts from approximately 350 thermally fractured pieces of similar size so produced. The most misleading pseudo artifacts, however, are the small flake-like or core-like specimens made of fine grained calcrete, such as the above core-like piece from Devil's Lair (Fig. 8:3), and the two experimentally produced flake-like, fire-fractured pieces in Figs 8:1,2. Finally, it should be mentioned that all such pieces from Devil's Lair or produced experimentally are light to dark grey in colour, whereas south-western calcrete, including all the calcrete artifacts described below, is usually cream-coloured, light brown or yellowish.

### LIMESTONE ARTIFACTS (Table 2)

Close examination of more than 10,000 limestone fragments, ranging in size < 1 cm - > 30 cm maximum dimension, from layers 29 to 38 in Trenches 2, 7c, 7d, 8<sub>2</sub>, 8<sub>7</sub>, 9 and 10 revealed more than 50 fractured specimens classifiable as possible artifacts. Approximately 20 other specimens, all of which are almost certainly artificially flaked or fractured, are classified as probable artifacts. Fourteen flaked specimens have been identified as unequivocal artifacts, and all but one of these are made of fine grained calcrete. No artifacts or any other kind of archaeological material have been identified from layers 39 to 51 in test Trench 8-9 (Figs 2,4), though several calcrete possible artifacts were recovered from layer 39.

The calcrete artifacts listed in Table 2 can be grouped as follows:

- retouched or flaked pieces - 4
- denticulated or notched pieces - 4
- flakes - 6

No certain cores of any kind have been recovered from layer 29 or below. A flaked calcrete fragment (B5098) from layer 29 is possibly a small core; and a multi-platform flake core fallen from section probably came from one of the layers between 31 and 38.

The illustrated specimens described below include the clearest examples of calcrete artifacts from these layers, as well as pieces of special interest.

*retouched or flaked pieces* - The elongate fragment in Fig. 10:1 has semi-abrupt apparent retouch extending over one long edge. This specimen seems to have been broken off a larger retouched piece, perhaps a flake scraper.

The multi-faceted, retouched fragment in Fig. 10:3 has a number of very clear negative flake scars. Its left hand edge (left edge of figure) consists of a single, elongate flake scar or break which truncates an invasively flaked surface whose proximal edge is lightly retouched, or perhaps utilised. Possibly this specimen is a retouched remnant of a small core.

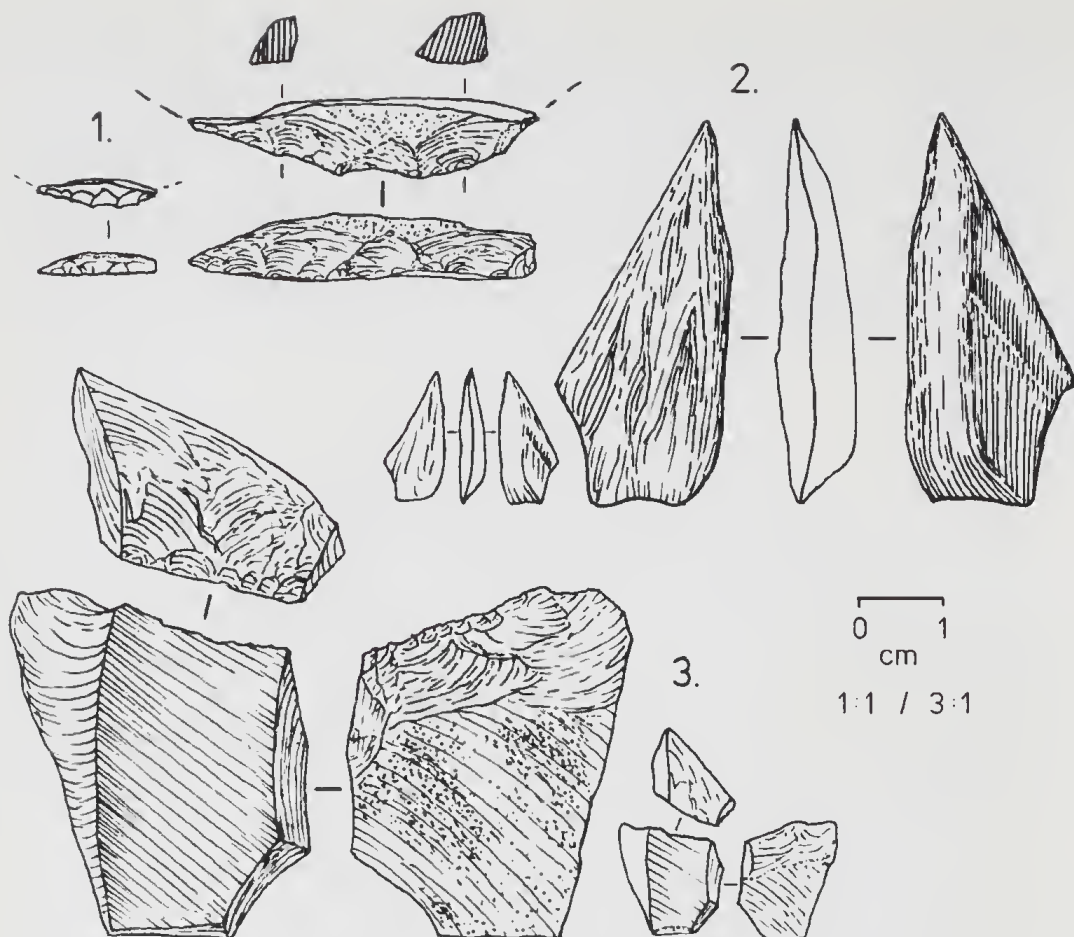


Fig. 10. Calcrete artifacts and a pointed bone tool (specimen 2) from Devil's Lair.

The bifacially flaked fragment in **Fig. 11:3** is the only certain aeolianite artifact from layers 29 to 38. Several of its flake scars are clearly invasive; and the alternate flaking on one of the edges (shown vertically in side view and on the adjacent edges of the adjoining views) forms a sinuous edge. Although some of the smaller flake scars on the edges of this piece could conceivably be the result of natural sources of percussion, it seems impossible that the invasive flaking on this piece could be natural. The piece is also notched on one corner (lower left corner of left hand view).

*denticulated or notched pieces* – The best example of this group is the flake in **Fig. 11:2** which is both notched and denticulated. This flake's dorsal face is a natural surface; its left hand edge is roughly denticulated (i.e. it has a series of closely adjacent small notches resulting in a toothed or saw-like edge); and its right hand edge has several well separated "Clactonian" or single-blow notches (i.e. deeply concave

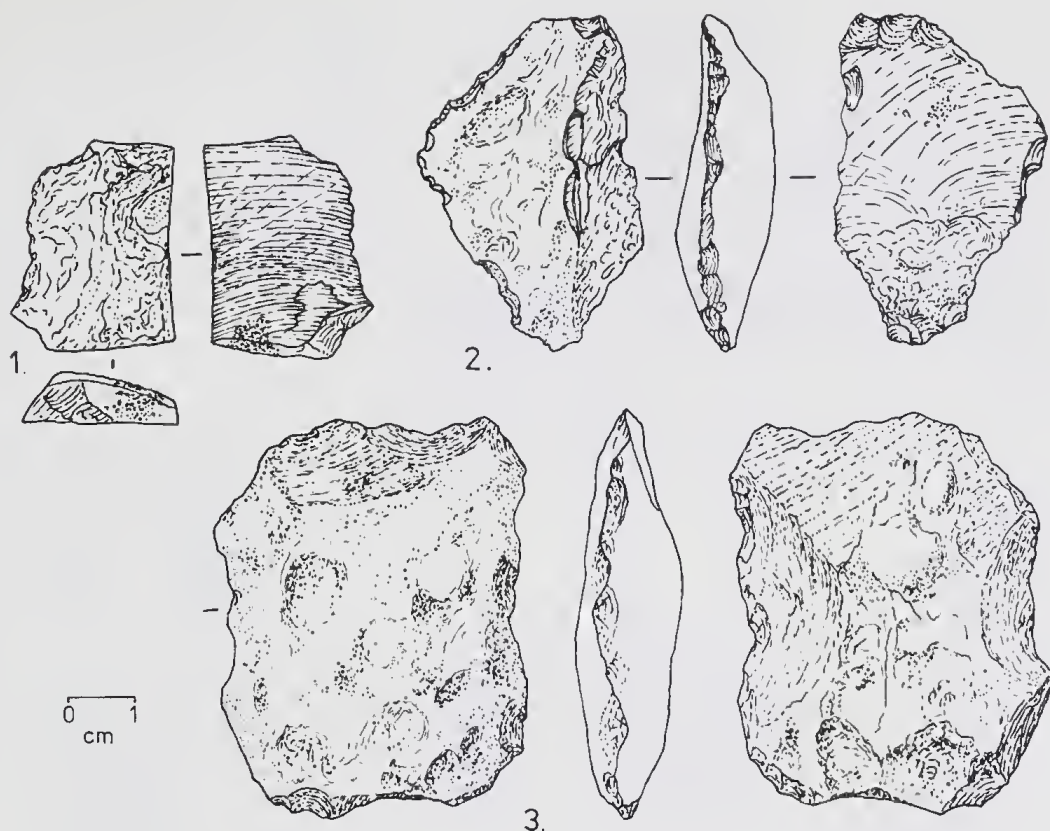


Fig. 11. Calcrete and aeolianite artifacts from Devil's Lair.

negative flake scars). The proximal end of the left edge has a large shallow, apparently retouched notch. The piece has shattering on the distal and proximal extremities of its bulbar face probably resulting from bipolar percussion; its bulb of percussion is obscured by this shattering, and also because this part of the flake is somewhat coarser grained than the distal half.

Another piece (Fig. 12:4), classified as a denticulated flake, has several closely adjacent very small notches along its right edge.

The elongate, triangular-sectioned fragment in Fig. 13:1 has a number of alternately flaked single-blow notches along one of its lateral edges. The uppermost extremity of this piece appears to have been snapped off.

*flakes* – Several flakes are illustrated in Figs 11:1 and 12:1-3. The flake in Fig. 12:1 has very well developed conchoidal fractures, and those in Figs 12:2, 3 have sub-conchoidal fractures. The butt of the flake in Fig. 11:1 is partially struck off. This flake has very clear edge chipping on both lateral edges which may be the result of utilisation.

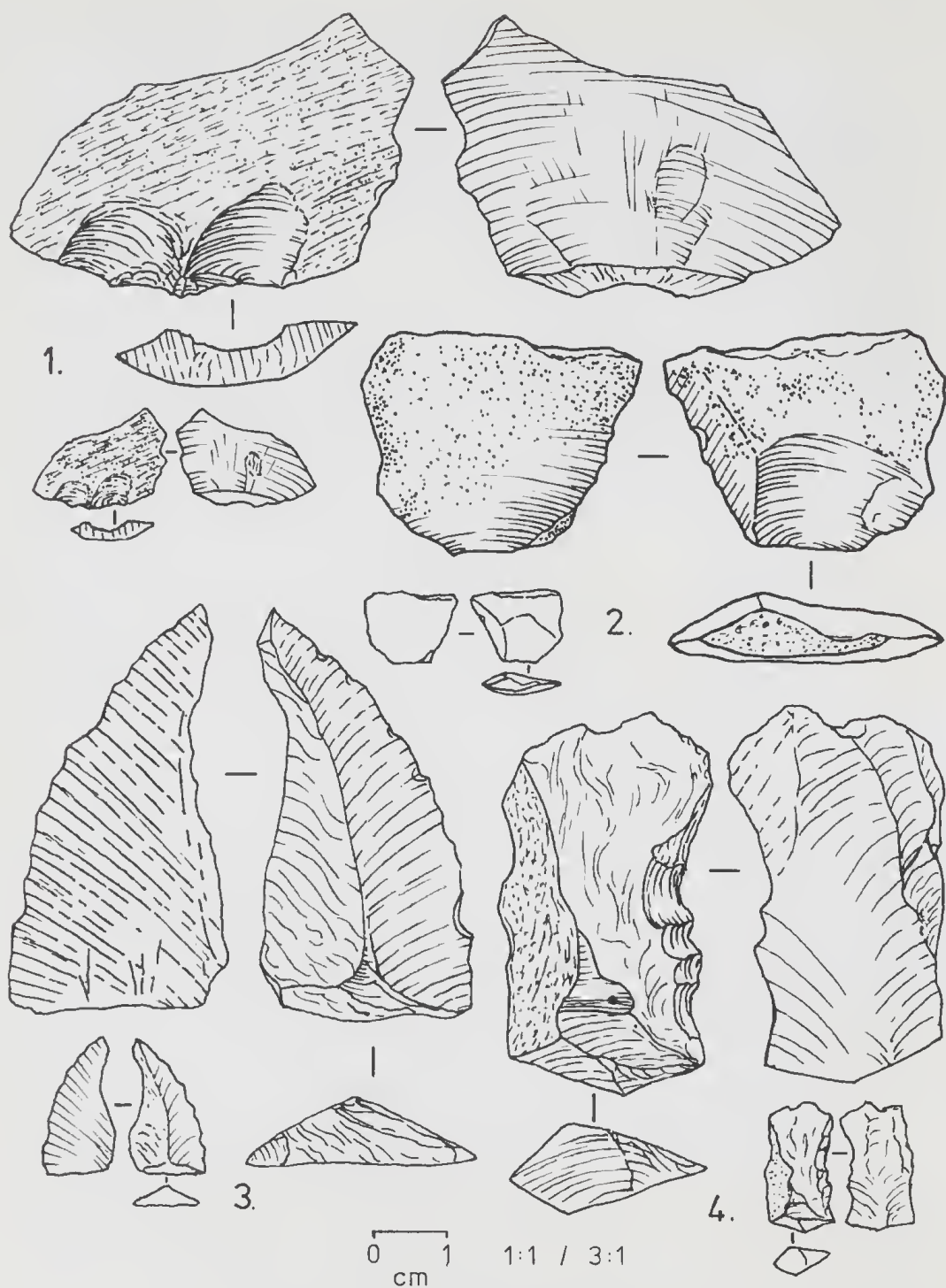


Fig. 12. Calcrete flakes from Devil's Lair.



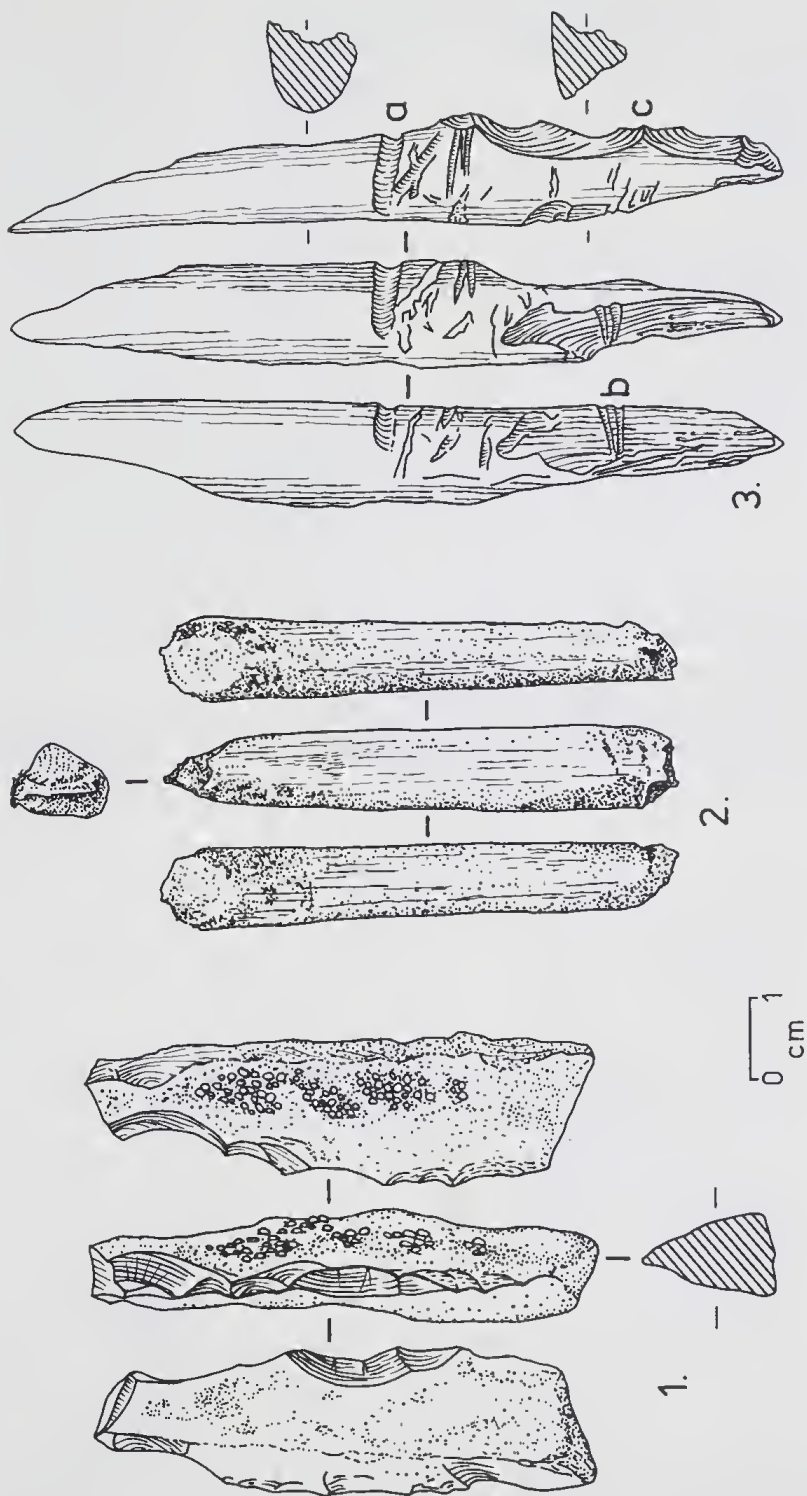


Fig. 13. An alternately notched calcrete fragment (1), a double bevelled bone probable artifact (2), and a grooved, incised and flaked bone splinter (3) from Devil's Lair.

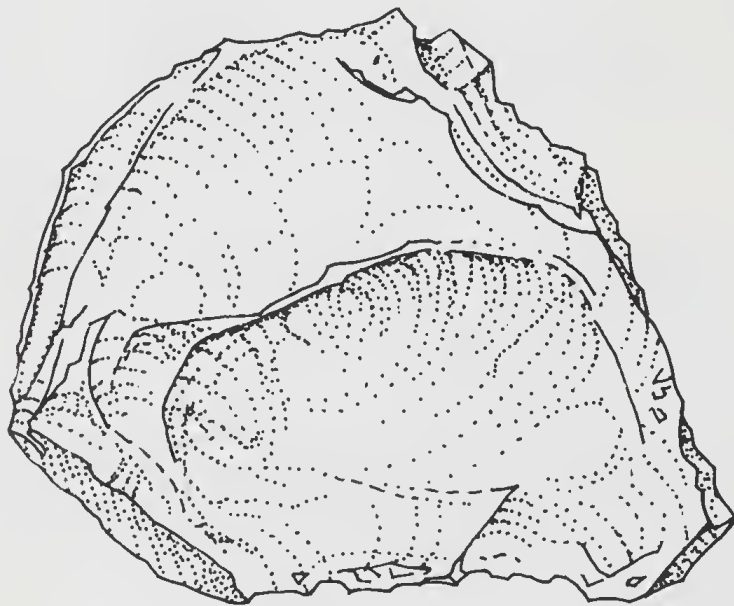


## OTHER STONE ARTIFACTS (Table 2)

Noted here are artifacts from layers 29-34 made of stone which is foreign to the limestone environment of Devil's Lair and its vicinity. Layers 29 and 30-upper yielded ten quartz artifacts all of which are classifiable as *débitage* (flaked material from stone knapping). This relatively large group of quartz artifacts much more resembles artifact assemblages in layers above 29 than it does the very scant calcrete assemblages below. The presence of such an assemblage in layers 29 and 30-upper seems to support the earlier suggestion that layer 30 represents a widening of the cave entrance which enabled people, perhaps for the first time, to occupy the cave itself.

From layer 30-lower and below only two artifacts made of anomalous stone have been recovered. The first of these is a chip of biotite granite (pers. comm. J.E. Glover) coming from a mixture of layers 30-lower and 31. The nearest surface sources of this stone, and also of quartz, are in exposures of gneiss either five km east of Devil's Lair; or on the coast five km west of the site. Gneiss is also exposed in the stream bed in Strong's Cave 30-40 m almost directly below Devil's Lair (Williamson, Loveday and Loveday 1976); and it is possible that ancient people obtained stone from there.

The second piece, a flaked opaline fragment (**Fig. 14**) from a mixture of layers 33 and 34, is described mineralogically by Glover (Glover 1979), who also discusses



**Fig. 14.** An opaline flaked fragment from Devil's Lair (cf. Glover 1979, Pl. 1). The maximum width of this piece is 4.72 mm.

possible sources of this stone. This tiny artifact is interpreted as a fragment from the retouching or breakage of a larger piece. Its main significance, as well as that of the quartz and biotite-granite specimens above, is in providing evidence that people were in or near the cave before or during the time that layers 29-33, and perhaps 34, accumulated.

### **BONE ARTIFACTS AND BONE PROBABLE ARTIFACTS (Tables 2,3)**

Only three of the several thousand pieces of bone from layers 29-38 have been identified as artifacts. Two other pieces described below are regarded as probable artifacts; at least 50 others in these layers are classifiable as possible artifacts since they resemble the bone debris resulting from various artificial methods of shattering limb bones. However rockfall can cause similar fractures on bones; and it is possible that this was an important source of natural bone fracture at Devil's Lair. The category of possible artifacts is then necessary because with many kinds of bone fractures, just as was earlier shown with limestone, there seems little way of distinguishing artificial from natural percussion, particularly rockfall.

Bone chewing by animals is another important source of bone fracture in Devil's Lair (Baynes, Merrilees and Porter 1975, p.102). In the case of small, easily shattered bones it is probably impossible to know whether clean edged fractures clearly resulting from percussion are artificial, or were caused by animal chewing or rockfall.

When found, two of the three bone artifacts (specimens B5260 and B3692; **Table 2**) and both probable artifacts (B3690 and B3693; **Table 3**) were thickly and entirely covered with the distinctive carbonate cement tentatively regarded as representing a re-deposited element among the finds from the lower layers in the Devil's Lair deposit.

The first bone artifact (**Fig. 15**) comes from layer 29 and is a length of tibia shaft from a Western Grey Kangaroo (*Macropus fuliginosus*: pers. comm. J. Balme). Clean edged breaks such as these on a bone shaft of this size and thickness are probably not the result of animal chewing but are caused by violent, explosive impact, either natural or artificial. They resemble very closely fractures produced experimentally by striking fresh or dry limb bones against anvil edges, as for example the kangaroo femur in **Fig. 16:1**, which was broken by two separate blows against an anvil edge with the bone held in the manner illustrated in **Fig. 16:4**. Similar breaks can be produced by dropping limestone fragments on limb bones exposed in various arrangements simulating likely rockfall situations in Devil's Lair. For example the kangaroo metatarsal in **Fig. 16:2**, while lying across two bricks, was broken by two strikes of a 1.5 kg limestone fragment dropped from a height of 1 m.

Table 2

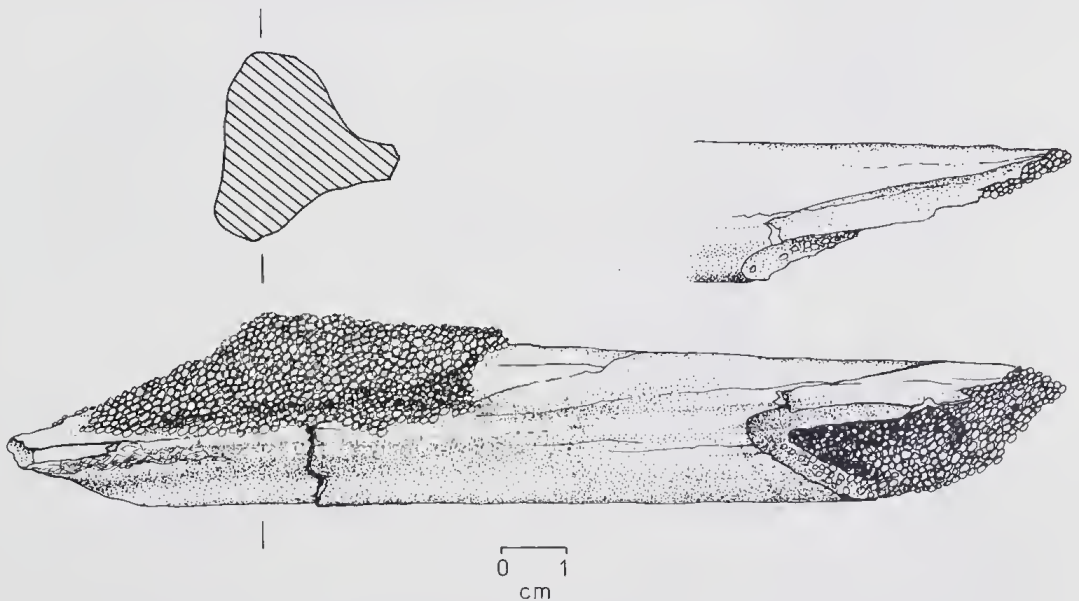
29 stone and bone artifacts from layers 29-38, Devil's Lair, Western Australia.

W.A. Museum Registration Number	Calcrete* Artifacts	Other Artifacts	Layer	Depth below cave datum in cm	Trench	Illustration
B5259		2 quartz flaked fragments	29	316-323	7c	
B5260		1 fractured tibia shaft	29	316-323	7c	Fig. 15
B5245	1 notched flake		29	331-340	7d	
B5098	1 flaked fragment	1 quartz flaked fragment	29	335-340	8 <sub>7</sub>	
B3761		1 pointed bone tool, 1 quartz flaked fragment, 1 quartz flake, 2 quartz chips	29	333-340	9	Fig. 10:2
B5279		1 quartz fragment	29	339-342	10 South	
B5173		1 quartz chip	30, upper	342-347	9 North	
B5288		1 quartz chip	30, upper	342-347	10 North	
B5101		1 biotite granite chip	30-31, mixed	358-370	8 <sub>7</sub>	
B5103	1 alternately notched fragment		32	370-385	8 <sub>7</sub>	Fig. 13:1
B5258		1 opaline flaked fragment	33-34, mixed	c. 400	8 <sub>7</sub>	Fig. 14 cf. Glover 1979.pl.1
B5132	1 flake		34	405-419	2	Fig. 12:2
B5240	1 retouched fragment		34	400-414	7d	Fig. 10:1
B5180	1 denticulated and notched flake		34	400-421	9 North	Fig. 11:2
B5266	1 denticulated flake		35	393-404	7c	Fig. 10:4
	1 flake					
B5270	1 flake		37	404-409	7c	Fig. 12:1
B5109	1 bifacially flaked fragment	(*This specimen is made of aeolianite)	37	432-437	8 <sub>7</sub>	Fig. 11:3
B5136	1 multi-faceted retouched fragment		38	440	2	Fig. 10:3
B5298	1 flake		38	409	7c	
B3692		1 grooved, incised and flaked bone splinter	38	c. 440	7d	Fig. 13:3
B5185	1 flake		38	447	9 North	Fig. 11:1
B5203	1 flake		38	446	9 South	Fig. 12:3
TOTAL	14	15 (10 quartz, 2 other stone, 3 bone)				

The metatarsal in **Fig. 16:3** was broken by a single strike of a 2.5 kg limestone fragment dropped from a height of 3 m; in this case the bone's shaft was wedged within a stack of bricks with only its proximal end exposed.

Similar rockfall experiments aimed at removing both articular ends of limb bones to produce double truncated shafts, such as those in **Fig. 15** and **Fig. 16:1**, centre, were not successful. One end of the limb bone was first broken off by impact from falling rocks as done with the piece in **Fig. 16:3**. Then the truncated shaft was reversed in the stack of bricks, and the intact articular end was subjected to rockfall. Even under controlled, optimum conditions such as these it was not possible in over 50 attempts with different fresh bones to produce an intact length of limb bone shaft with both ends cleanly broken off, though continued drops under these controlled conditions might eventually produce such bones. In experiments with dry bone general shattering of the shaft occurred.

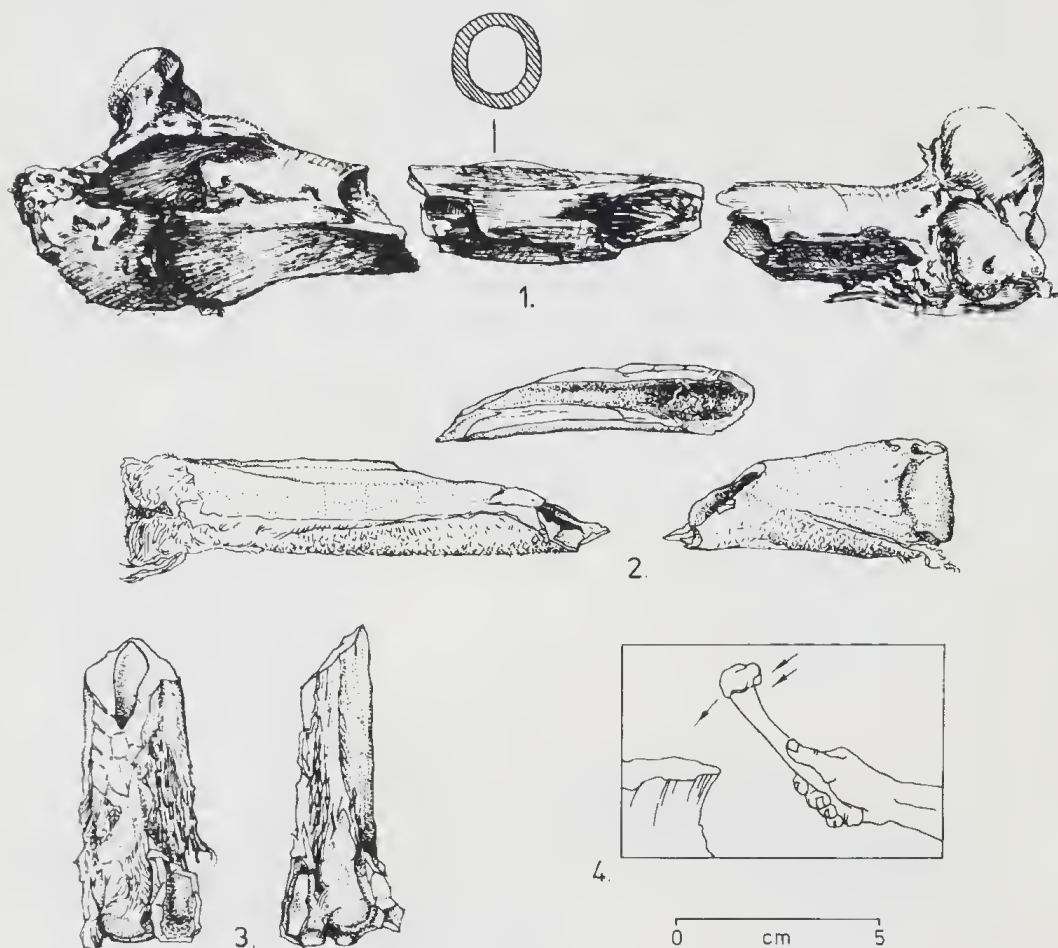
It is deduced from experimental rockfall and replication, within the context of Devil's Lair, and with regard only to large limb bones as discussed here, that bone shafts with both articular ends cleanly broken off almost certainly result from artificial percussion and not from rockfall. Judging by the very brief, though concentrated effort required it seems reasonable to assume that these truncated limb bone shafts were deliberately broken, either by two separate blows against an anvil edge in the manner illustrated in **Fig. 16:4**; or by resting the shaft on a ridge of rock and then striking it with a hammerstone. It is suggested that the articular ends were removed from limb bones for the purpose of obtaining marrow.



**Fig. 15.** An artificially fractured *Macropus fuliginosus* tibia shaft from Devil's Lair.



The bone in **Fig. 15** also has several sharp-edged, V-sectioned incisions up to 25 mm long and 0.2 mm wide, as well as elongate shallow striations all of which are judged as artificial, since they closely resemble incisions and other marks experimentally made on bone shafts with calcrete and quartz flakes. Most of these marks are oriented longitudinally on the bone shaft. The elongate incisions' dimensions and orientation, and the multiple striations do not resemble scratches or incisions made by animals' teeth, such as on bones (e.g. 65.11.11 and 68.2.41) kept in the palaeontological collection, Western Australian Museum. In addition to having been beneath the carbonate crust, some of the incisions contain partial infilling of carbonate showing clearly that the marks predate the encrustation of this bone. (All these marks are on the opposite side of the piece as illustrated in **Fig. 15**.)



**Fig. 16.** A kangaroo femur (specimen 1) experimentally broken by percussion against an anvil edge as shown in 4; and two kangaroo metatarsals (specimens 2,3) broken in experimental rockfall under simulated natural conditions.



A second bone artifact also from layer 29 (**Fig. 10:2**) is the only one of the three described which was not covered in carbonate cement. This is a very small pointed bone fragment which is extensively polished and worn over the whole of both faces. Its surface, under x12.5 - x50 magnification, shows no striations or, with one exception, other linear marks attributable to manufacture by abrasion or cutting (cf. Newcomer 1974, pp.148-149). The two features on this piece which are considered to be evidence of artificial modification are the straight V-sectioned mark on one face (**Fig. 10:2**, right); and the clearly scooped out part of one side of one face of the pointed extremity (inner edges of left and right views in **Fig. 10:2**).

This artifact's method of manufacture is problematical. Possibly it is simply a fragment of convenient shape collected from bone debris resulting from the shattering of a large limb bone. Despite its small size the piece could have been an awl used in gouging holes in skins. Whatever its possible function, any use resulted only in a deep polish and not in striations though it is possible that the scooped out part of the pointed extremity was also caused by extensive use.

The last bone artifact (**Fig. 13:3**), from layer 38, is an elongate, weathered bone splinter, probably part of a *Macropus fuliginosus* tibia (pers. comm. J. Balme). The piece has extensive and varied surface modifications labelled on the different views of the figure as follows: (a) U-sectioned grooves (the uppermost, very large groove is 10 mm long; 2.8 mm wide; and about 1 mm deep); (b) two narrow, closely adjacent and relatively deep, straight incisions (one is V-sectioned); and (c) three sub-conchoidal negative flake scars (the largest is about 22 mm wide). The two groups of marks labelled (b) and (c) and probably also the (a) group were made after the splinter had been removed from the bone shaft.

The piece is classifiable as an artifact; it is not interpreted as a tool since it seems incomplete, and none of its edges shows signs of wear. Its identification is based on the following criteria. First, the splinter itself and all the marks on it can be quickly and easily replicated on fresh or dry bone, using the simplest stone tools (an anvil, a flake and a hammerstone). Second, although ease of replication does not prove that the marks are artificial, it is still purely conjectural whether animals could have produced the uppermost U-sectioned groove (a); the largest sub-conchoidal fracture (c); or the two closely adjacent, sub-parallel, straight incisions (b). Obviously the possibility cannot be ruled out entirely that the marks were made by one of the larger marsupial carnivores or possible carnivores which lived in this part of the south west 30,000 or more years ago, i.e. the Tasmanian Devil (*Sarcophilus harrisi*), the Thylacine (*Thylacinus cynocephalus*), or the "marsupial lion" (*Thylacoleo* sp.) (Balme, Merrilees and Porter in press, Table 3; Merrilees 1968, pp.11-12). But this origin for the marks cannot be tested easily since practically nothing is known of the diet and habits of *Thylacoleo*; nor is very much known of the bone chewing

capabilities of Thylacines. As for Tasmanian Devils, at least the largest U-sectioned groove (a), and the small V-sectioned incision (b) seem well outside the size and shape ranges of this species' teeth marks, judging by collections of bones chewed by these animals (e.g. palaeontological specimens 65.11.11). Taking these uncertainties into account, the piece in **Fig. 13:3** is regarded as an artifact until a more plausible alternative can be suggested.

The two carbonate encrusted pieces classified as probable bone artifacts (**Table 3**), are of particular interest since both may be made on bones of extinct marsupials. The first of these (**Fig. 13:2**), from layer 32, is a broken, weathered long bone shaft, without a cavity, which has a double-bevelled edge at one end. The bone has been examined by staff of Palaeontology Department, Western Australian Museum, and described by them as follows:

We have compared B3693 with various anatomical structures of a number of species, ancient and modern, and have found no close match. The virtual absence of a central cavity and the form suggest that it comes from a fibula, nearer the proximal end. By elimination, we suggest it represents *Sthenurus* but we have insufficient comparative material to verify this.

(pers comm. D. Merrilees, J. Balme, J. Porter.)

The bone's bevelled surfaces are much the same size and are slanted at much the same angle, and meet to form a roughly convex edge. Microscopic examination (up to x50 magnification) shows no signs of artificial cutting or abrasion of the bevels, or of the edge they form. A few of several marks on the shaft are possibly artificial; most others, including some on both bevels, are shallow indentations and short, curving shallow grooves resembling animal tooth marks.

There seems to be no form of animal activity, or any other natural force which can produce a double bevelled extremity on a solid bone shaft. Experimental replication shows that such a feature can be produced on one broken end of the solid section of a kangaroo fibula, fresh or dry, with very little effort. The end of the bone is simply rubbed vigorously against a sandy limestone surface, first on one side and then the other; less than two minutes' such abrasion suffices to create a bevelled edge similar to that of the Devil's Lair specimen. Furthermore the edge so produced is sharp, tough and capable of being quickly re-sharpened.

The apparent lack of natural agencies which could produce a double bevelled extremity and the ease with which double bevels can be made seem evidence enough to suggest that the bone is an artifact. However the total lack of any definite marks of artificial modification prevents this specimen from being classified as a definite artifact.

The second probable bone artifact, from layer 31 (**Fig. 17, Table 3**), has been identified as a metatarsal from a macropodine much larger than *Macropus*

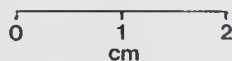
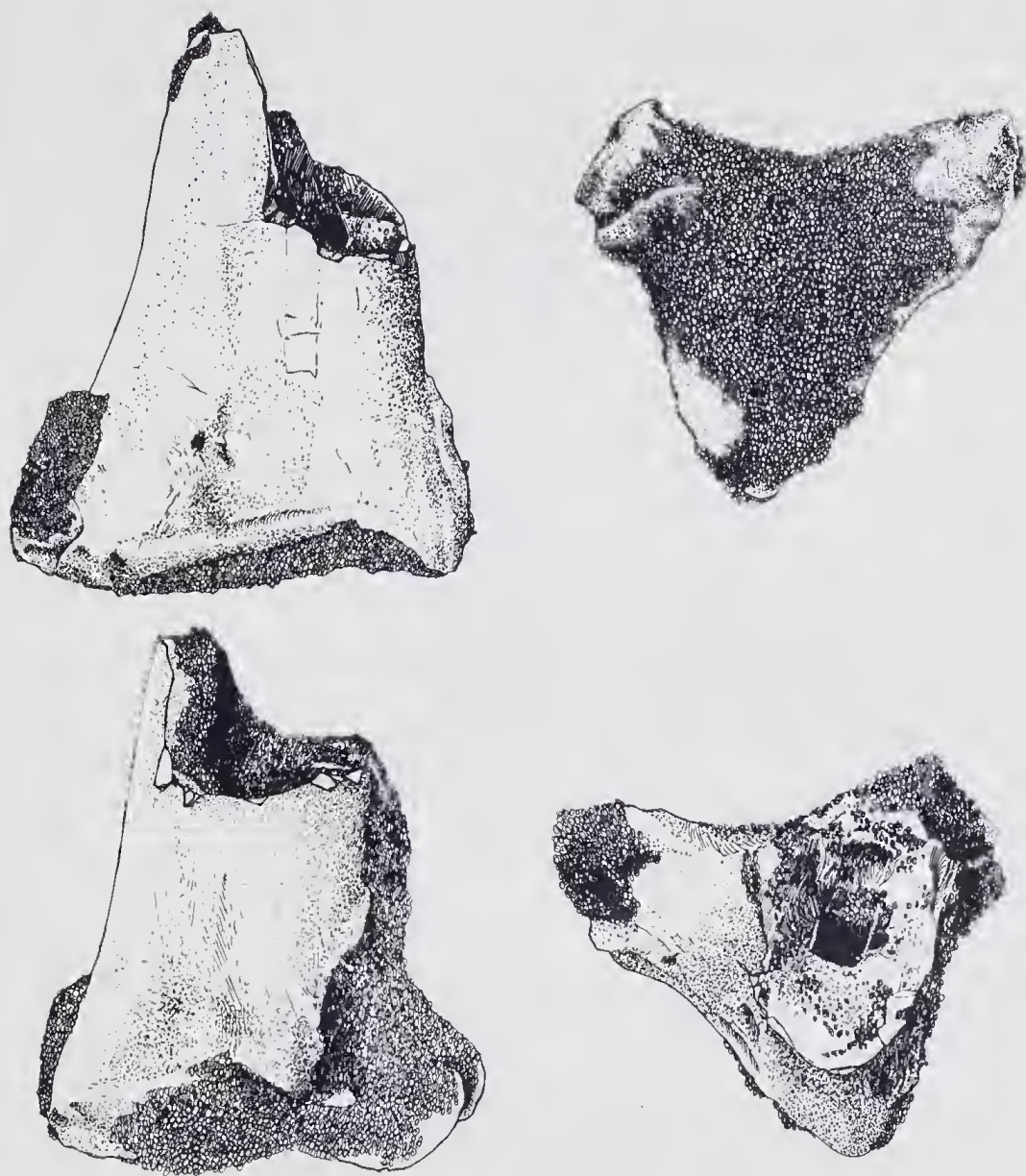


Fig. 17. A probably artificially broken metatarsal from Devil's Lair, possibly belonging to the extinct macropod *Protemnodon*.



*fuliginosus* and possibly *Protemnodon brehus* (pers. comm. D. Merrilees). The prominent curving fracture shown in the left hand views of the piece, and shown end-on in the lower right hand view, resembles very closely those produced experimentally by striking limb bones against anvil edges (e.g. **Fig. 16:1**); and it seems probable that this fracture was made in the manner shown in **Fig. 16:4**. Moreover it does not seem likely that rockfall at Devil's Lair could have caused such a cleanly fractured edge on a bone this thick (cf. lower right hand view in the figure). Nevertheless the much smaller kangaroo metatarsal in **Fig. 16:3** was broken by rockfall, and the possibility of rockfall having caused the fracture on the piece in **Fig. 17** cannot be precluded.

### LIMESTONE PROBABLE ARTIFACTS (Table 3)

Several limestone specimens classified as probable artifacts warrant description since they help provide a probably truer picture of the limestone artifact assemblages from layers 29-38 than can be shown only from the study of those pieces listed in **Table 2** as definite artifacts.

**Table 3**

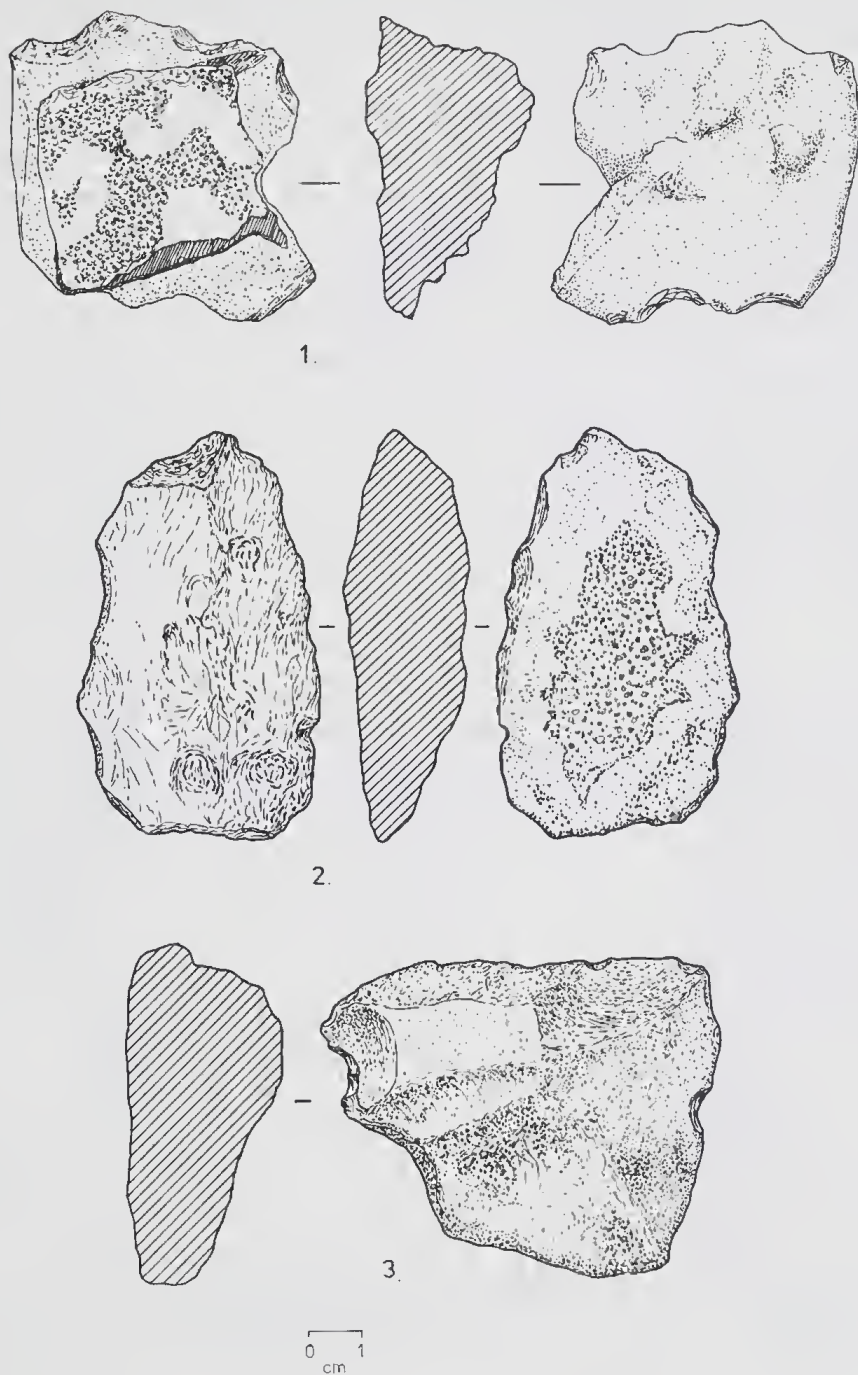
Selected limestone and two bone probable artifacts and other finds from layers 30-38, Devil's Lair, Western Australia.

W.A. Museum Registration number	Description (All specimens are limestone probable artifacts except where otherwise indicated)	Layer	Depth below cave datum in cm	Trench	Illustration
B5297	1 fragment of turban shell*	30	326-345	7c	
B5129	1 alternately notched fragment	31	357-373	7d	Fig. 18:1
B3690	1 fractured metatarsal, from a large macropod†	31	358-370	8 <sub>7</sub>	Fig. 17
B5299	1 fragment of marine bivalve shell	32	381-395	9 North	
B3693	1 double bevelled bone, probably a macropod fibula‡	32	383-406	9 South	Fig. 13:2
B5156	1 notched flake	32	403	8 <sub>2</sub>	Fig. 18:2
B5237	1 notched flake	33	c. 399	7d	Fig. 18:3
B5106/1	one half of a fractured limestone fragment	33	section cleaning	7d, 8 <sub>7</sub> , 9	Fig. 20
B5119	one half of a fractured limestone fragment	33-34, mixed	c. 400	8 <sub>7</sub>	Fig. 20
B5116	1 flaked fragment	34	section cleaning	7d, 8 <sub>7</sub> , 9	Fig. 19:1
B5298	1 notched fragment	38	409	7c	Fig. 19:2
B3684	1 quartz pebble	38	449	2	Fig. 21:2

\* *Turbo (Ninella) whiteleyi* (Iredale): pers. comm. G.W. Kendrick

† possibly *Protemnodon*: pers. comm. D. Merrilees

‡ possibly *Sthenurus*: pers. comm. D. Merrilees, J. Balme, J. Porter



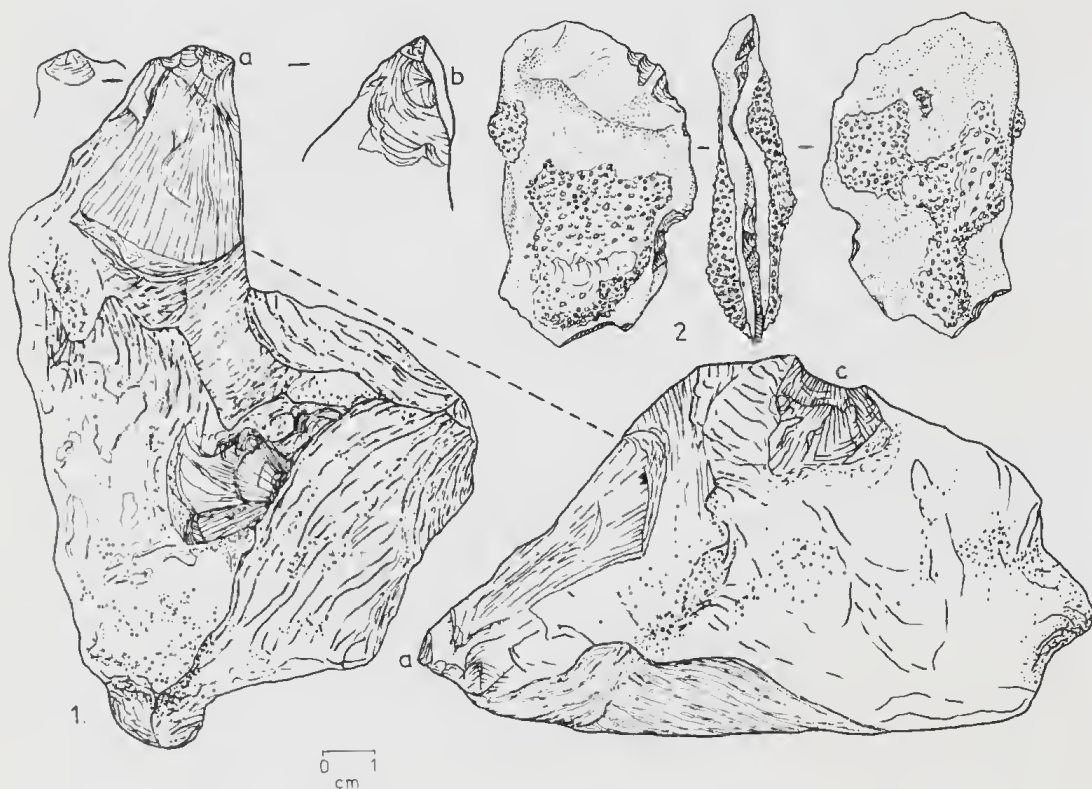
**Fig. 18.** Three limestone probable artifacts from Devil's Lair.



The probable artifacts include some simple flakes and chips, and simple flaked fragments made of fine textured calcrete, as well as several more complex pieces made of coarser grained limestone, three of which are described here. The first two of these, illustrated in **Figs 18:2,3**, seem to be heavily weathered flakes. Both pieces have notches, and the notch on the left hand edge of the piece in **Fig. 18:3** appears retouched. The piece in **Fig. 18:2** has a number of single-blow notches on both lateral edges.

The third piece (**Fig. 18:1**) is a weathered calcrete fragment with an alternately arranged series of apparent notches on two opposite edges (upper and lower, as illustrated). I suggest that this piece is classifiable as a probable artifact since it is difficult to see how such an arrangement of notches could have been produced naturally. It is probably correct to say that this piece, like the two described above, is not acceptable as a definite artifact only because it consists of relatively granular material which has subsequently weathered to the extent that diagnostic elements of its suggested artificial features have been obliterated.

A different problem arises with the notched piece in **Fig. 19:2** which is not a probable flake but a weathered calcrete slab with sandy carbonate cement on both

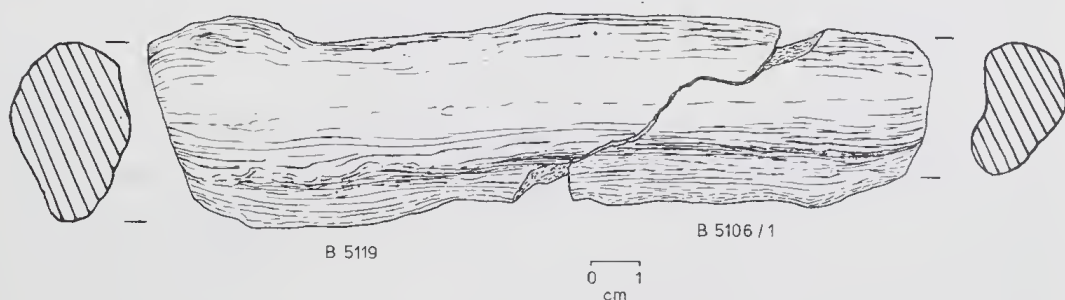


**Fig. 19.** Two limestone probable artifacts from Devil's Lair.

faces. One edge has a single large apparently retouched notch consisting of at least four partly overlapping flake scars. This notch has a fresh texture and had been covered by a sandy carbonate encrustation. It is very similar to experimentally produced retouched notches on calcrete, yet it is the sole feature on this piece which seems of artificial origin; and this is not sufficient evidence to enable the piece to be classified as a certain artifact.

Another specimen, illustrated in **Fig. 19:1**, is a massive piece of fine grained calcrete which has three differently oriented, sub-conchoidal negative flake scars (**a,b,c**). In addition to the prominent, hinged flake scar (**a**) and the smaller adjacent scar (**b**), the pointed extremity of this piece has some minor flaking which could be either natural damage or the result of utilisation. This piece is not identifiable as an artifact because it is only a simple flaked piece. That is, all of its flake scars have been produced by percussion against natural surfaces, and almost certainly the flakes removed would have been of the simple variety which, as shown above, can result from rockfall. However the flake scars show well developed fissures and some rippling typical of artificial percussion, and which were not produced in the rockfall experiments. From this it is concluded that the piece probably is an artifact.

A final specimen (**Fig. 20**), comprising two halves of an elongate piece of weathered, rough-textured, strongly lithified limestone, perhaps a root concretion, is of particular importance since it may be evidence that people entered the cave during the deposition of layers 33 and 34. The two halves of this specimen were found no more than one m apart in layer 33 (part B5106/1), and a mixture of layers 33 and 34 (part B5119; cf. **Table 3**). The rejoinable, angled central break is much more recent than the extremely weathered fracture surfaces at the ends of the piece. The fact that the two halves were found very close together and at much the same depth and stratigraphic position must mean that the piece was broken within or very near the area of the main excavation, probably on an exposed surface of layer 33. The only plausible sources of stone fracture in this situation are rockfall and human action.



**Fig. 20.** A probably artificially broken piece of limestone from Devil's Lair.

The two surfaces of the central break exhibit typical uneven fracture, and from neither can the direction of the blow or the point of impact be determined, though the latter may be present on one of the two missing parts of the two halves. It is considered that a sharply angled break of this nature is much more likely to have been produced by the piece being struck against the edge of an anvil rather than by other means of artificial percussion, or by rockfall. Experimentation with various means of artificial percussion and with simulated rockfall on similar limestone pieces should provide clues for the origin of this fracture. For the present this piece is regarded as a probable artifact, and is thus the only tentative evidence that people entered the cave at times prior to the deposition of layer 30.

### OTHER SMALL FINDS (Table 3)

The only specimens here of certain archaeological significance are two fragments of marine mollusc shell, each measuring six mm across. The first is a piece of turban shell from layer 30, and the second a probable bivalve shell fragment from layer 32. Each piece has been shown by X-ray diffraction analysis to be composed of aragonite (W.A. Government Chemical Laboratories Report 60243-44/78: pers. comm. D. Burns); and thus each is a fragment of marine shell preserving its original crystalline structure (i.e. the aragonitic form of calcium carbonate), rather than being a calcite cast fallen or leached out of the dune limestone in which Devil's Lair is formed. The only plausible explanation for the presence of these shells in Devil's Lair seems to be that they were humanly transported as much as 30 km from a former coastline (cf. Balme, Merrilees and Porter in press, Fig. 11). It is practically impossible to deduce even the likely range of human activities these tiny specimens could represent, beyond of course the obvious possibilities that people were eating marine shellfish and using their shells as tools or ornaments. Their occurrence in layers dated to 32,800 BP makes them much the same age as scatters of freshwater mussel shells interpreted as human food remains from Lake Mungo, New South Wales (Barbetti and Allen 1972, Table 1; Bowler 1976, p.59).

The objects in **Fig. 21** are quartz pebbles; one (**Fig. 21:2**) is from layer 38, the other two (**Figs 21:1,3**) are emu cropstones collected in the Murchison district, W.A. by Dr S.J.J. Davies, Division of Wildlife Research, C.S.I.R.O. The Devil's Lair specimen is well within the size and weight range of emu cropstones (pers. comm. S.J.J. Davies), though whether it is a cropstone washed or fallen into the cave through natural circumstances; or one derived from the butchering of an emu; or a pebble brought by a person to the cave from coastal or inland sources cannot be decided, since all seem equally likely possibilities.

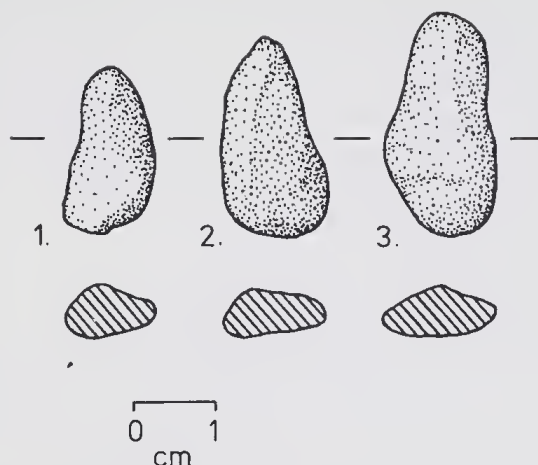


Fig. 21. A quartz pebble from Devil's Lair (specimen 2), and two quartz emu cropstones from the Murchison district (specimens 1, 3).

Layers 29-38 at Devil's Lair, like most of the layers above 29, contain small quantities of charred bone fragments. Charred bone is very plentiful in some of the Devil's Lair hearths; and it is obvious that kitchen activities within and perhaps immediately outside the cave are one important source of charred bone. However very small amounts of some charred bone in the zone below layer 38 where artifacts have not been found may mean that charred bone deriving from bush fires was occasionally washed into the deposit. A separate archaeological study of charred bone at Devil's Lair is presently underway.

## DISCUSSION

The main purpose of this and Glover's accompanying paper (Glover 1979) has been to demonstrate that the part of the Devil's Lair cave deposit dated at 33,000 BP contains an archaeological element. Yet some tentative interpretations of the artifacts can be made. Firstly, though most of the stone artifacts resemble quarrying or workshop waste material it is probably valid to refer to some pieces as apparently retouched or utilised tools, i.e. the calcrete specimens illustrated in **Figs 10:3,4; 11:2; and 13:1**. The pointed bone artifact in **Fig. 10:2** has already been described as a tool,



and possibly the bone in Fig. 13:2, if it is indeed an artifact, was also a tool. Since apparent tools are present it seems correct to refer to this material as a collection of tools, *débitage* and debris intermittently washed into this part of the cave deposit from occupation sites perhaps within the former entrance or immediately outside the cave. Worth re-emphasising is the broken limestone fragment in Fig. 20 which, could it be shown to be unequivocally an artifact, would constitute evidence for occasional human occupation, or at least a momentary human presence in the position of the main excavation at 33,000 BP.

Aside from the two fragments of marine shell possibly representing mollusc eating, only two of the artifacts suggest anything about the probable diet of the ancient people living around Devil's Lair. These are the two artifacts made on limb bones of the Western Grey Kangaroo (Figs 13:3; 14) which, assuming that artificially modified bones nearly always belong to species preyed on by human beings, can be regarded as direct evidence that Aborigines living around Devil's Lair 30,000 or more years ago hunted this species, just as they did here and in other parts of the south west in more recent periods (Baynes, Merrilees and Porter 1975, pp.102-104); and for ethnohistorical evidence (Meagher 1974).

It is probable that people who hunted the Western Grey Kangaroo were also capable of successfully hunting the extinct large macropods *Sthenurus* and *Protemnodon*, and perhaps other large extinct marsupials represented among the fauna in layers 31-38 (Balme, Merrilees and Porter in press, Table 3). This is suggested by the two bone probable artifacts in Figs 13:2 and 17, both of which may be made on the bones of the two named extinct animals, though this evidence seems less significant for people having hunting large, now extinct species than does the presence of the two definite artifacts noted above which are made on large kangaroo bones. In any case better evidence than this from Devil's Lair for the hunting of extinct macropods in this part of the south west comes from Mammoth Cave, 11 km north of Devil's Lair, where several bone artifacts, perhaps considerably older than the Devil's Lair assemblage described here (Merrilees 1968, p.10), are made on *Sthenurus* limb bones (W.A. Museum palaeontological collection specimens 67.11.46; 68.2.27; Archer, Crawford and Merrilees in preparation).

Although not weakening the very strong case for a prey-predator relationship between large macropods and human beings living around Devil's Lair 33,000 years ago, it is nevertheless not yet possible in the channel-cut layers 31-38 to establish definite stratigraphical association between any of the faunal remains, stone or bone artifacts, or other finds. All that can be said about these finds, encrusted or not, from this part of the deposit is that some at least of the bones are contemporaneous with each other and with some of the stone or bone artifacts; and that many if not most or all of the encrusted bones and artifacts are likely to be older than many,



perhaps most of the specimens without encrustations. Some of the encrusted bones and artifacts may well be derived from parts of the cave deposit pre-dating  $37,500 \pm 750$  BP (SUA698), the radiocarbon age of the mid-part of layer 39 (Fig. 4). The absence of artifacts in layers 39-51 does not seem significant since this part of the deposit contains very few animal bones, or even large stones below layer 39. Nor are the  $1.1 \text{ m}^3$  of sediments removed from Test Trench 8-9 (Figs 2,4) sufficient to constitute a definitive sample from this part of the deposit.

With the exception of the opal artifact (Fig. 14) which suggests possible relatively long-range group movement or contact in the lower south west, the stone artifacts reveal very little about the economy of the culture they represent. Technologically they show only that flakes, sometimes notched or denticulated, may have been used as tools in cutting and perhaps woodworking or other tasks involving shaving or scraping. The very small size of some of the apparent tools (Figs 10:2-4), or fragmentary apparent tools (Fig. 10:1) does not seem unusual since very small tools are common in more recent assemblages at Devil's Lair, at Miriwun in the Ord valley, and at other late Pleistocene sites in Western Australia (Dortch 1977; Dortch and Merrilees 1973).

As noted earlier, layer 29, with its relative abundance of quartz seems to belong to the upper part of the industrial sequence where both quartz and chert are common (Dortch and Merrilees 1973), rather than to the channel-cut zone. The near absence below layer 29 of quartz, a stone which is very common in almost all south-western prehistoric artifact assemblages, is difficult to explain. For the present it can only be said that the pattern of Aboriginal stone use in the locality around Devil's Lair was in some way different during the time these lower layers were deposited from that of later periods in this district when quartz and also chert were commonly used (Dortch 1974; Dortch and Merrilees 1973; Glover 1974; 1975).

The small assemblages of artifacts from layers 29-38 are among the very oldest, reliably dated specimens yet recovered in Australia; and they are roughly comparable in age with the stone artifact assemblages from Lake Mungo, N.S.W. and Keilor, Vic. (Barbetti and Allen 1972; Bowler 1976; Mulvaney 1975). Although yielding very little information relating to patterns of prehistoric subsistence or settlement, the presence of this archaeological material of advanced age in the extreme south-west helps provide a firm basis for further investigations into the duration of human occupation in Western Australia.

### ACKNOWLEDGEMENTS

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# **THE MINERAL PROPERTIES AND PROBABLE PROVENANCE OF A 33,000 YEAR OLD OPALINE ARTIFACT FROM DEVIL'S LAIR, SOUTH-WESTERN AUSTRALIA**

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## **ABSTRACT**

An opaline artifact, 33,000 years old, with the curious property of periodically changing colour, has been recovered from Devil's Lair, in south-western Western Australia. Its provenance is uncertain, but it is likely to have come from an amygdale in the Bunbury Basalt.

## **INTRODUCTION**

In March 1976 a small conchoidally fractured mineral fragment, identified by Dortch as a flaked artifact, and having the remarkable property of periodically changing colour, was recovered by Western Australian Museum excavators from a part of the cave deposit at Devil's Lair radiocarbon dated at 33,000 years B.P. (for discussion of age and typology see Dortch 1979). The specimen, number B5258 in the Archaeological Collection of the Western Australian Museum, comes from a mixture of layers 33 and 34 in Trench 8, depth *circa* 400 cm below cave datum. The following note describes its mineralogy and probable provenance.

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## MINERALOGY

The specimen measured 4.72 x 3.81 x 2.56 mm before fragmentation (**P. 1; Fig. 1**), and changed from time to time in the laboratory from clear, transparent, greyish yellow (5YR8/4) and translucent, moderate yellowish-brown (10YR5/4) to opaque white (N9) (colours from Rock-color Chart Committee, 1963). When clear, examination with the binocular microscope revealed small areas showing a play of colour. The mineral has no cleavage, but is cut by irregular cracks, and in fact split along the larger cracks when immersed in a mixture of water and Clericis Solution to determine its specific gravity. The apparent initial specific gravity of the specimen was 1.84, but with increasing fragmentation and the elimination of some cracks, the apparent specific gravity of individual grains rose, and approached 2.0.

In oils, under the polarizing microscope, the mineral is colourless to very pale greyish yellow. It is isotropic with a refractive index of  $1.453 \pm 0.002$ , and is therefore opal. Some cracks are lined with feathery to dendritic coatings of greyish orange (10YR7/4), to moderate brown (5YR4/4) and greyish black (N2) cloudy mineral which is white in reflected light. Other cracks change from white through various colours of the spectrum when the stage is rotated. This phenomenon is probably caused by a film of air, and is responsible for the play of colour mentioned earlier.

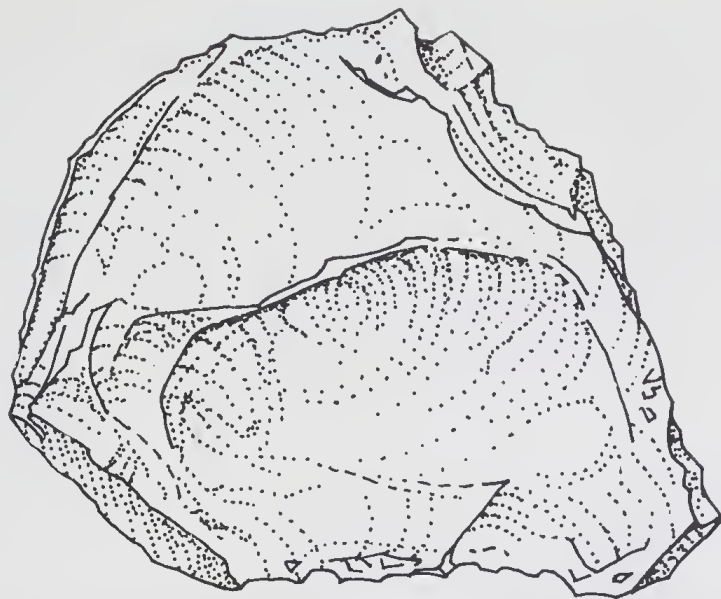
The mineral was shown to be non-crystalline by an X-ray powder photograph, verifying the optical determination of opal. The remarkable colour changes noted in the hand specimen are probably caused by absorption of varying amounts of water from the atmosphere as the humidity changes.

## PROBABLE ORIGIN AND PROVENANCE

Opal is known in two rock types from south-western Australia, namely chert of the Late Eocene Plantagenet Group, and siliceous amygdaloids of the Early Cretaceous Bunbury Basalt. Neither source can be ruled out at present, but the possibility of derivation from the basalt is the stronger.

The Bunbury Basalt crops out sporadically between the Darling Fault on the east, and the Leeuwin Block on the west (see **Fig. 2**). Basalt is also predicted from aeromagnetic data to be present off-shore north-west of Bunbury, and along parts of the southern coast between Augusta and the Darling Fault. By contrast, no Plantagenet Group rocks are known west of the Darling Fault, and they form a patchy veneer on the Precambrian basement to the east.

Opal has been observed, together with chalcedony, quartz, calcite and zeolites in amygdaloids in Bunbury Basalt dredged from the floor of Bunbury harbour in 1974. Some amygdaloids are up to 20cm long, and are used as ornaments. Large siliceous



**Fig. 1.** Line drawing of the opaline artifact from Devil's Lair, layers 33-34, Trench 8<sub>7</sub> (cf. Dortch 1979, Figs 2-5).



**Pl. 1.** Photograph of the opaline artifact from Devil's Lair. The specimen measures 4.72 x 3.81 x 2.56 mm.

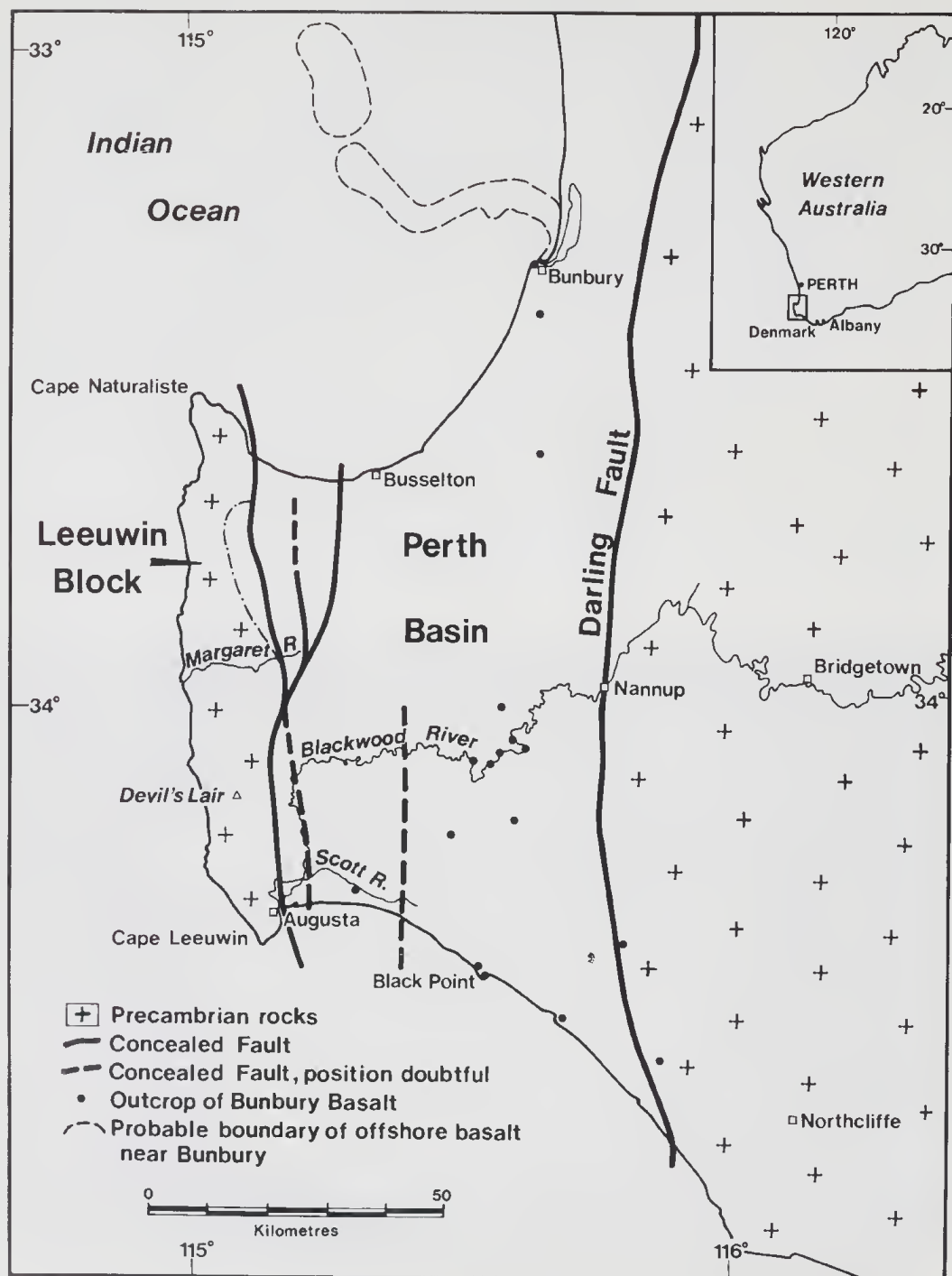


Fig. 2. Map of south-western Australia. Geology based on Lowry (1965).

amygdales containing some opal have been found near the top of the basalt in Gelorup Quarry, about 8km south of Bunbury. Siliceous amygdales are known from the Black Point area, but superficial work on their mineralogy has revealed no opal. It is of interest that broken, ovoid, siliceous bodies with radial and concentric textures, found on the surface roughly 1 km east of Black Point, may be amygdales that have been worked by Aborigines. Some fragments are about 10 cm long.

Colloform opal has been described in Plantagenet Group chert artifacts from Albany and Denmark (Glover 1975), and opal has also been observed in artifacts from the Northcliffe area (Dortch & Gardner 1976). It seems generally to form rather finely intergrown masses with chalcedony, and no flakes of pure opal appear so far to have been observed. Palimpsests of microfossils are present in some of the opal.

Opal is absent from chert artifacts described from surface scatters on the Perth Basin and Leeuwin Block. Most of these artifacts consist essentially of fossiliferous cryptocrystalline silica with a little chalcedony. It has been proposed that these artifacts came from an offshore source to the west (Glover 1975). A little opaline silica has been observed in the chambers of some microfossils in chert flakes recovered from Devil's Lair, but these flakes consist mainly of cryptocrystalline and microcrystalline silica and resemble the surface material from the Perth Basin and Leeuwin Block (Glover 1974). They differ texturally from flakes from Albany, Denmark and Northcliffe.

There are several considerations, none conclusive in itself, which suggest that the opal artifact in Devil's Lair originated in the Bunbury Basalt. The absence of microfossil remnants accords with an amygdaloidal origin. The size of the body makes it more likely to have come from a large amygdale than from the finely intergrown masses of opal and chalcedony in chert of the kind used for artifacts around Albany, Denmark and Northcliffe. The chert artifacts higher in the sequence at Devil's Lair show no petrographic evidence of derivation from the distant Plantagenet rocks. Finally, there is a band of basalt outcrops, some of which contain opaline amygdales, between Devil's Lair and the Plantagenet Group rocks to the east.

## CONCLUSIONS

The unusual mineral artifact from Trench 8, in Devil's Lair is opal. Its changes in colour are probably caused by absorption of moisture from the atmosphere. Its most likely provenance is amygdaloidal rock in the Bunbury Basalt, but it is not possible at present to be more precise about its origin. The presence of this stone, which is unequivocally an artifact, in the cave deposit indicates contacts or movements in the range 25-100 km by people living at Devil's Lair 33,000 years ago (Fig. 2).

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# THE PAST AND PRESENT DISTRIBUTION AND STATUS OF SEA LIONS AND FUR SEALS IN WESTERN AUSTRALIA

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## ABSTRACT

A comparison of the distribution and abundance of seals in Western Australia, according to accounts by early navigators and colonists with surveys made in 1974-7 shows that the Fur seal *Arctocephalus forsteri* (Lesson) has contracted in both distribution and abundance, whereas the Sea lion *Neophoca cinerea* (Péron) has declined only in abundance. The largest known Sea lion populations now occur on Beagle, Buller, Fisherman, Carnac, Middle Doubtful, Wedge and Daw Islands. The largest known Fur seal populations are on Eclipse and Middle Doubtful Islands, and on several islands in the Archipelago of the Recherche. The total size of Western Australian populations is about 700 Sea lions and about 400-500 Fur seals.

The abundance of the Sea lion on Carnac I. was monitored over three years, and was found to range from 25-32 animals. On Middle Doubtful Island both species of seal were present but were ecologically segregated. All Fur seals were found around the rocky shores, whereas Sea lions ascended as far as the summit (80m).

## INTRODUCTION

Once the coastline of South-western Australia was charted by Vancouver in 1791, British, Colonial and North American sealers were quick to move in and exploit the local seal populations, which comprised only two species. Sealing there was never subjected to any sophisticated control by sealers or by the British Government (Lockyer, 1827), with the inevitable result that the supply of both species of seals declined markedly by the 1830s. All the commonsense rules of harvesting a

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renewable resource were broken: the young as well as females were taken just as readily as males, and where possible all individuals on a single island were collected.

Because the pelt of the Fur seal (*Arctocephalus forsteri*) has a thick underfur in contrast to the coarse hair of the Sea lion (*Neophoca cinerea*), the skins of the former were in 1842 worth 15 shillings each at King George Sound, and two pounds and twenty five shillings in London, whereas those of the Sea lion fetched only 4-5 shillings each (Clark 1842). This probably also accounted for the greater hunting pressure on the Fur seal.

In this paper, I report on the following:

- (1) The past distribution and abundance of both pinniped species in Western Australia, gathered from a search of the reports of the early navigators and early colonists.
- (2) The current distribution and abundance of both seal species in Western Australia, derived mainly from a study in 1974-7 of island birds which enabled me to work on many islands between Shark Bay and the Archipelago of the Recherche. I have supplemented these data with published records.
- (3) The population of Sea lions on Carnac I. (near Perth) was counted in 1975-7 to see whether a seal population fluctuated over several years. I also include data on day-to-day variation in numbers.
- (4) Differences in the way that Fur seals and Sea lions use Middle Doubtful I. (near Bremer Bay) were studied. I also remark on the effect that Sea lions can have on island ecology.

## **PAST DISTRIBUTION AND ABUNDANCE OF PINNIPEDS IN WESTERN AUSTRALIA**

There are no past records of seals breeding on the mainland of Western Australia. For convenience, I have grouped the islands around South-western Australia into nine groups (**Fig. 1**). All records in this Section refer to the 18th and 19th centuries.

### **SHARK BAY ISLANDS (Fig. 1-A):**

Fur seal: no records.

Sea lion: There is only one record of a seal on rocks at Dirk Hartog I. in January 1822 (A. Cunningham in King 1827: 183). Baudin (in Cornell 1974: 512) wrote 'we have never seen a single seal here'. Péron (1807: 104-127), Freycinet (1807) and Péron and Freycinet (1816, Ch.30) also make no mention of any seals.

### **HOUTMAN ABROLHOS (Fig. 1-B):**

Fur seal: no records.

Sea lion: The present day Long I. in the Wallabi Group was called Seal's I. by the survivors of the *Batavia* wreck in 1629 (Drake-Brockman 1963), presumably

indicating a great abundance of Sea lions there. Survivors of the *Zeewyk* shipwreck in 1727 killed 147 Sea lions on the islands in the Pelsart Group (O'Loughlin 1969: 26). Gilbert (1843) noted that all the islands in the Wallabi Group were 'very thickly inhabited' by Sea lions, and that 'greater numbers' were seen on Pelsart I. A few Sea lions on Pelsart and Rat Is. were noted by Stokes (1846) when he charted the Abrolhos in April/May 1840.

#### ISLANDS BETWEEN DONGARA AND LANCELIN (Fig. 1-C):

I have found no detailed records of seals from these islands.

#### ISLANDS NEAR PERTH (Fig. 1-D):

Fur seal: Freycinet (1807: 189) saw a female seal suckling a black pup on Rottneest I. He recorded that the fur of most animals was fine and thick, which suggests the Fur seal. However, King (1827: 163) wrote that at Rottneest I., he was 'much disappointed in finding these animals were not of the fur seal species, as in M. de Freycinet's account of the island they are said to be'.

Sea lion: The Dutch navigators Voelkersen in 1658 and Vlamingh in 1696 recorded seals at Rottneest I., presumably of this species (Alexander 1914). Freycinet (1807: 184) noted that Garden I. was covered with a great number of seals, of which many were slaughtered. Seals were more numerous there than on Rottneest I. (Freycinet 1807: 191). At what is now called the Heirisson Is. (near the city of Perth), some of the crew heard (Freycinet 1807: 183) what must have been a seal. In January 1822, King (1827) found 'a great many' Sea lions on Rottneest I. Stirling (1827: 571) noted many seals on islands near Perth, and stated that all were Hair seals. In 1829, Lt. Breton saw 'an occasional seal' on Garden I. (Alexander 1918: 38), and T.B. Wilson saw one there (Alexander 1918: 39). Penguin I. was stated by Clark (1842) to be a 'favorite resort' of the Sea lion. Presumably they also occurred on Seal I. just north of Penguin I.

#### ISLANDS NEAR CAPE LEEUWIN: (Fig. 1-E):

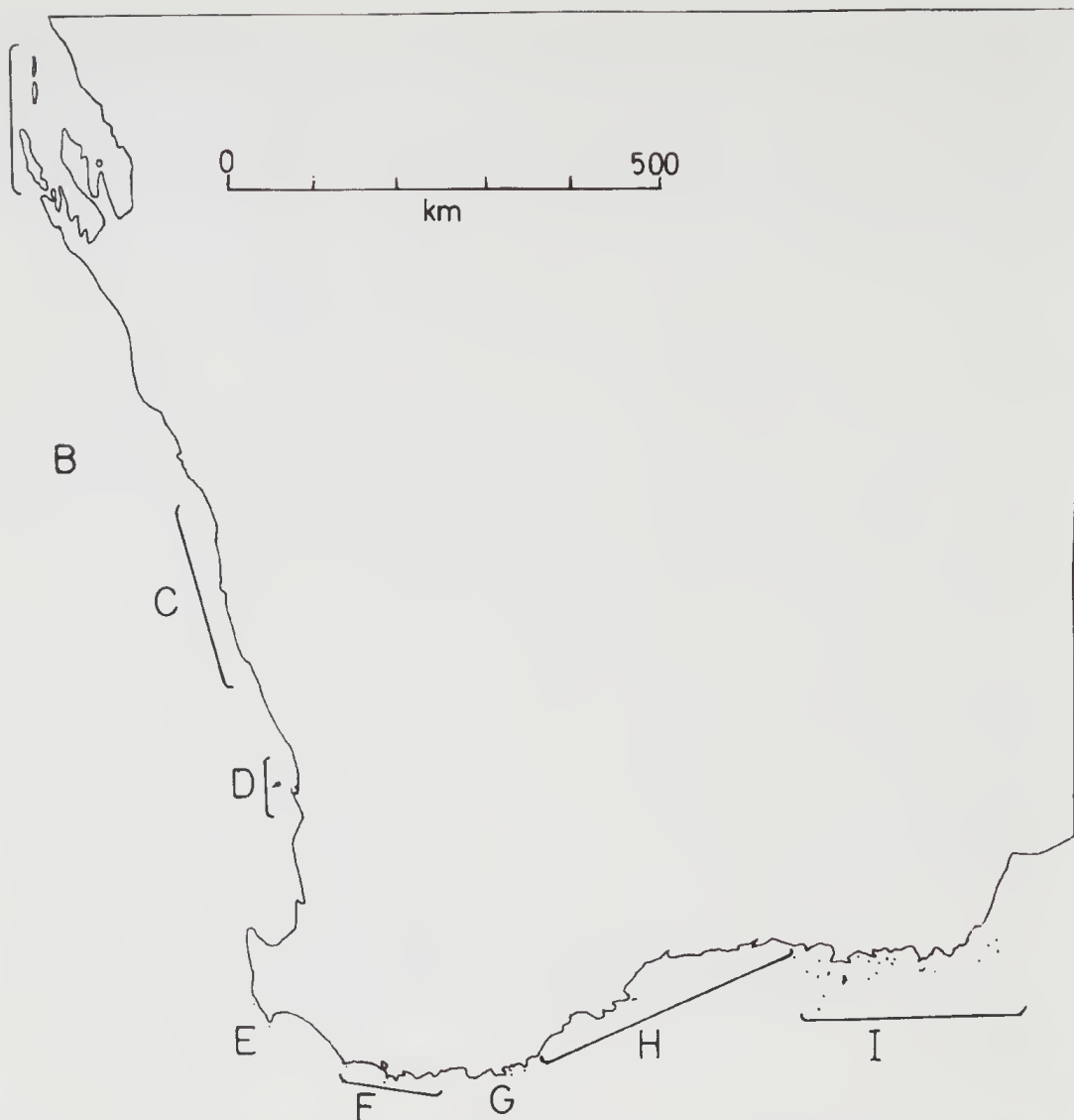
Fur Seal: Irwin in 1832 (Alexander 1918: 46) noted many Fur seals on these islands. Clark (1842) stated that on the voyage from Perth to Albany, Fur seals were first sighted on these islands.

Sea lion: I could find no records of Sea lions on these islands.

#### ISLANDS BETWEEN POINT D'ENTRECASTEAUX AND PT. HILLIER (Fig. 1-F):

Fur seal: Sandy I. was frequented 'in great numbers' by the Fur seal (Clark 1842). Clark also recorded Fur seals on Chatham, Saddle and Goose Is. None was recorded on Stanley I.

Sea lion: I have found no records of Sea lions occurring on these islands.



**FIG. 1:** Map of South-western Australia showing island groups referred to in text.

**A** = Shark Bay islands; **B** = Houtman Abrolhos; **C** = Dongara-Lancelin; **D** = near Perth; **E** = near Cape Leeuwin; **F** = Point d'Entrecasteaux to Point Hillier; **G** = Torbay to Coffin I.; **H** = Bald I. to Butty Head; **I** = Archipelago of the Recherche.

#### **ISLANDS BETWEEN TORBAY AND COFFIN I. (Fig. 1-G):**

Fur seal: King (1827) did not record Fur seals at King George Sound, but Lockyer (1827) noted them on Breaksea I. (one dozen) and on Michaelmas I. Sleeman (1829: 542) recorded that 12 Fur seal skins, 11 Sea lion skins and 29 pup skins were procured at King George Sound on 16th February 1829. Eclipse I. was much frequented by Fur seals, and sealers lived on the island (Lockyer 1827, Clark 1842). Collie (in

Cross 1833: 150) found no live seals on Coffin I. in June 1831, but found skeletons and only one path.

Sea lion: Vancouver (1801) in September 1791 named Seal I. in King George Sound because of the Sea lions there, of which at one time he counted 20 animals. Seals were still there in December 1801 (Flinders 1814), in February 1803 (Péron and Freycinet 1816: 141) and in January 1818 and December/January 1822 (King 1827). None was present on 28th January 1827 (Lockyer 1827: 478).

#### ISLANDS BETWEEN BALD I. AND BUTTY HEAD (Fig. 1-H):

Bald I. was frequently inhabited by sealers (Clark 1842). I found no published data for Haul-off Rock or Cheyne, Glasse, Doubtful, the two Red, Rocky or West Is.

#### ISLANDS IN THE ARCHIPELAGO OF THE RECHERCHE (Fig. 1-I):

Fur seal: In December 1792 La Billardiére (1800: 422-3) observed several Fur seals on Observatory I. He specifically stated that all seals were of the one species, the small one (p.425). However, he described their colours as white, dark grey or brown approaching black, thus suggesting that Sea lions occurred too.

Sea lion: Flinders (1814) stated that all of the islands in this Archipelago were 'more or less frequented by seals'. Most were stated to be Hair seals (= Sea lions). The islands in the Recherche were said to be a great rendezvous of sealers (Clark 1842). Lockyer (1827: 498-9) mentions the instance of sealers, left for 18 months on the coast near the islands, as having 100 Fur seal pelts when they arrived at King George Sound. A further 700 skins were left on an island in the Archipelago.

Thus, in summary, before the advent of the sealers, Fur seals ranged from the Archipelago of the Recherche to islands off Cape Leeuwin. Sea lions were found from this Archipelago to Houtman Abrolhos, with a record of a presumed vagrant at Dirk Hartog I. in 1822.

### CURRENT DISTRIBUTION AND ABUNDANCE OF PINNIPEDS IN WESTERN AUSTRALIA

This is chiefly based on two-week long visits to the following islands by the author: Bernier, Dirk Hartog, East Wallabi, Pelsart, Rottneest, Carnac, Garden, Hamelin, Sandy, Chatham, Eclipse, Breaksea, Michaelmas, Bald, Middle Doubtful, Woody and Mondrain Islands. Brief visits (several hours to three days) were made to: Eagle Islet, Shark Bay; West Wallabi, Seagull, Pigeon, Long, Beacon, and Gun Is. (Houtman Abrolhos); Boullanger, Whitlock, and Eclipse Is. and Essex Rocks (Jurien Bay); Lancelin and Edward Is.; nearly all (121) islands and islets near Perth; nearly all (13) islands in or near King George Sound, Coffin I., West Doubtful I., and Wilson and Salisbury Is. (Archipelago of the Recherche). In addition, informa-



tion is included from other scientists' visits to Bernier and Dorre Is. (Ride and Tyndale-Biscoe 1962), Houtman Abrolhos (Storr 1960, 1965; Anon. 1964, 1965; O'Loughlin 1969; Green 1972), Fisherman Is. (R.E. Johnstone in Chapman and Kitchener 1977), islands between Dongara and Lancelin (Ford 1963, 1965, unpublished), Bald I. (Storr 1965), the Archipelago of the Recherche (Serventy 1953, Lindgren 1956, King 1969, Shaughnessy 1970), and S. Fowler's flights in 1945 over various islands (R.M. Warneke, pers. comm.).

There is one known mainland breeding site (Reilly 1974 and pers. comm.). On 22 October 1973, three males, 14 females and five suckling young Sea lions were found at the base of the cliffs 4 km west of Twilight Cove. All other breeding records pertain to islands.

#### SHARK BAY ISLANDS:

Ride and Tyndale-Biscoe (1962: 85) saw no seals on Dorre or Bernier Is., and I saw none on Bernier or Dirk Hartog Is.

#### HOUTMAN ABROLHOS:

Sea lions are now uncommon. Alexander (1922) records, without details, only a few individuals. I saw none during the month that I spent there (October 1975). Storr (1960, 1965) quotes several sightings on North I., and one sighting near West Wallabi. He found the remains of a male on West Wallabi. One bull, one cow and two pups were seen on Jubilee I., and a "small group" was seen on Gun I. in the Pelsart Group (O'Loughlin 1969: 26). One was seen off Pigeon I. in the Wallabi Group (Anon. 1964: 23). However none was seen on five islands in the Wallabi Group in 1965 (Anon. 1965) or in the Easter and Pelsart Group in 1970 (Green 1972). Several were present on Long I. in the Wallabi Group when Bill Peach filmed a documentary there (Peach's Australia), but no further details are available. Two Sea lions were present on an islet on Morning Reef on 27.5.78, and small groups have been seen there on other occasions by Museum staff (B.R. Wilson, pers. comm.). Local fishermen today use the name 'Seal Island' for this small, divided islet. There are specimens from Rat and West Wallabi Islands in the collections of the Western Australian Museum.

#### ISLANDS BETWEEN DONGARA AND LANCELIN:

I found two Sea lions on North Essex rock. Julian Ford (pers. comm.) has recorded Sea lions as follows: Beagle Islets (about 50, 26.5.61), Fisherman Is. (about 40, 12.12.61), Sandland I. (about 20, 15.7.62), North Essex rock (3-4 on three visits), South Cervantes I. (18, with suckling young on 28.10.61, but only two on 29.10.62), Buller I. (30 on 28.10.61, 14 on 30.12.62), Green Islets (no counts made). R.E. Johnstone has visited the Fisherman Is. over 30 times since 1971 at all times of the year. Numbers ranged from 5-52 (Chapman and Kitchener 1977). S. Fowler

recorded two on North Cervantes I. in June 1945, 22 on North Fisherman I. in July 1945 and one on South Green It. in June 1945.

#### ISLANDS NEAR PERTH:

Sea lions are said to occur on Dyer I. (near Rottnest), but none was present on both my visits. However, John Turner (pers. comm.) visited Dyer I. briefly each month during 1975, and found one old bull present each visit. Sea lions are now extinct on Rottnest and Garden Is., but a stable population (20-30 seals) occurs on Carnac I. (see below). I have seen single seals or their faeces on Bird I., West Tub Rock and West Sister I. There are specimens in the Western Australian Museum from Swanbourne Beach, Woodman Point, Robb Jetty, Yanchep, Lake Preston and Penguin I.

#### ISLANDS NEAR CAPE LEEUWIN:

Fur seal: now extinct. I saw none on Hamelin I., and Gillham (1963) did not record any from Hamelin, Seal or St. Alouarn Is. J. Lane (pers. comm.) has not seen any on several recent (1976) visits to St. Alouarn.

Sea lion: no records.

#### ISLANDS BETWEEN POINT D'ENTRECASTEAUX AND PT. HILLIER:

Fur seal: extinct on Sandy and Chatham I. None was seen on the White-topped Rocks or Goose I., which were flown over at low altitude in April 1977. None was seen on Stanley I. when viewed through binoculars from Pt. Hillier. Occasionally a Fur seal comes ashore at Windy Harbour (D. Beale, pers. comm.)

Sea lion: no records.

#### ISLANDS BETWEEN TORBAY AND COFFIN I.:

Fur seal: Seventy were counted in April 1975 on Eclipse I., where most were in a gorge at the N.E. corner of the island. Two or three seals were occasionally seen on the southern shores of the island. King (1969) found pups on Eclipse I. in 1967. One was seen on Breaksea I., and two (including a pup) on Michaelmas I. These probably represent strays. There are certainly no rookeries on these two islands. Four seals were seen, at close range, on Rock Dunder. On Coffin I. 15 were present. Sokolowski (1976) recorded 29 in May 1976 on Coffin I., and stated that he had counted 50 seals there at other times. However, these were identified (erroneously) as Sea lions.

Sea lion: extinct on Seal I. A few were reported to occur on Eclipse I. by the lighthouse staff, though none was present during my visit. King (pers. comm.) saw three adult males, one subadult male, and 3-4 juvenile males or females on Eclipse I. in February 1967. However these were casual sightings and not necessarily the total island population. There were no Sea lions present on Breaksea, Michaelmas, Mistaken, Coffin or Green (Oyster Harbour) Is., or on Rock Dunder or Gull Rock.

## ISLANDS BETWEEN BALD I. AND BUTTY HEAD:

Fur seal: on Bald I., about half way down the eastern side, were 15 Fur seals on a small rock about 5m high, just offshore. I also saw one Fur seal on a small rock off the southern side of the island. On Middle Doubtful I., 86 Fur seals were counted (details below), and on West Doubtful I. four were seen in pools of water. S. Fowler in May 1945 saw about 80 unidentifiable seals on Rocky Is.; from the similarity of these islands to the Doubtful Is. I would expect most of these to be Fur seals.

Sea lion: on Bald I., I found one dead at the landing place, and I saw three animals (in water) on 19th May 1976. Half way down the eastern side of the island I found old faeces and bones which represent a haul-out site of this species. Storr (1965) recorded a subadult male on Bald I., and noted them as common at nearby Cheyne Beach. Trails of this species could be clearly seen all over Haul-off Rock when I flew over this island in April 1977. D. Pearson of Albany (pers. comm.) has noted them as being very common on this island. S. Fowler recorded about 40 Sea lions on Haul-off Rock in June 1945.

On Middle Doubtful I., I counted 41 Sea lions, and I saw old faeces on West and East Doubtful Islands. Seals (?species) are occasionally seen on Glasse I., Bremer Bay and on Seal (or Cruiser) Rock, Doubtful Island Bay (P. Spurr, pers. comm.). S. Fowler recorded about 20 Sea lions on the Smooth Rocks, about 80 on West I. in May 1945, and one on the Rocky Is.

## ISLANDS IN THE ARCHIPELAGO OF THE RECHERCHE:

Both species are widespread, but no seals were recorded on the following islands by Serventy (1953) or Bassett Hull (1922): Charley, Rabbit, Gunton, Sandy Hook, Woody, Long, Remark, Pasco, North and South Twin Peaks, and Middle Is. I did not find any on Woody or Wilson Is.

Fur seal: this species has been recorded on Seal Rock (about 150 in July 1945, S. Fowler; at least 100 pups in February 1967, King, pers. comm.; at least 37 animals, Shaughnessy 1970), Fur Rock (about 40 in July 1945, S. Fowler), Hood I. (at least 15 animals, Shaughnessy 1970), and on Daw I., formerly called Christmas I. (100 animals in 1948 and 50 animals in 1950, Serventy 1953; 100 in 1960, King 1969). About 10 animals including one pup in 1977 were present on Salisbury I. King (1969) quotes local information that Figure of Eight, Capps and Boxer Is. have Fur seals present. However her records of Round, Mondrain, Wedge, Middle and Termination Is. as having Fur seals probably represent a mis-reading of Serventy (1953). On Mondrain I. in April 1977, two Fur seals were present on the north-central point. S. Fowler in 1945 counted the following: Douglas, about six in May; George I., 30 in June; Glennie I., about 40 including young in May.

Sea lion: Serventy (1953) recorded Sea lions on thirteen of the 21 islands visited: Figure of Eight (2), Seal Rock (20), Boxer (1), Termination (20, breeding), Thomas

(1), Round (20, breeding), Mondrain (5), Wedge (40, breeding), Combe (10), Goose (1 dead), Douglas (10, breeding), Salisbury (20) and Daw (65, breeding). Lindgren (1956) recorded five Sea lions and three skeletons on Lion I. On Mondrain I., two adult males were seen at the landing place in February 1976, one skeleton was found half way down the eastern coast of the island, and in April 1977, four Sea lions were seen on the north-central point of the island. There are three specimens in the Western Australian Museum from Pasley I. and one from one of the Twin Peaks Islands. In May 1945 S. Fowler recorded Sea lions on rocks close to the mainland at Point Malcolm (12) and Israelite Bay (6). Seals, species not determined, were also recorded by S. Fowler in 1945 on the following additional islands: Helby (3), Hugo (8), Marts Group (8), Slipper (1).

In 1920, sealers took 494 Fur seals and 327 Sea lions in the Archipelago of the Recherche (Serventy 1953).

Thus the present range of the Sea lion in Western Australia corresponds with its range early last century, but the Sea lion has decreased in abundance on islands near the cities of Albany and Perth, and at Houtman Abrolhos. They remain in moderately large numbers on several islands between Dongara and Lancelin. The total population size in Western Australia is about 700 individuals.

The Fur seal is now extinct over a third of its former range in Western Australia (between Cape Leeuwin and Eclipse I.). The total known population size in Western Australia is about 400-500 individuals.

Independent corroboration of my conclusions about distribution along the south coast of Western Australia is given by Barwick (p.95 in Le Souef and Burrell 1926). He records that ' . . . every island and the adjacent mainland from the Eastern Group [of the Archipelago of the Recherche] to Eclipse Islands. . . are at frequent intervals visited by both hair- and fur-seals.' This implies that by the 1920s neither species was found along the south coast west of Eclipse I.

#### SEASONAL AND DIURNAL CHANGES IN ABUNDANCE OF SEA LIONS ON CARNAC I., 1975-7.

I counted the number of Sea lions ashore on the eastern beach of Carnac I. about one hour before dark on eight visits to the island. I spent ten weeks on the island between 1975-7, but neglected to count seals on the first two visits. The counts in **Table 1** represent the largest number of animals hauled out of any count made during that week.

The number of Sea lions present showed remarkable constancy, and only varied from 25 to 32 animals. There was no apparent seasonality in abundance (**Table 1**). The numbers counted each day (one hour before dusk) during the last three visits were as follows:



August/September 1976: 14, 15, 22, 25, 7, 26;  
 November 1976: 17, 32, 29, 32, 32, 32;  
 January 1977: 26, -, 26, 23, 27, 28;

Although the numbers in August/September 1976 and in November 1976 showed a marked daily fluctuation in numbers, those in January 1977 were more constant. A possible explanation is that food is more difficult to find in September and November, so that seals have to spend more time hunting for food.

On Carnac I. during the day only a few seals haul-out. This is when many tourists visit the eastern beach. I have never seen seals using the two western beaches, which are hardly ever visited by tourists. The Sea lions on Carnac I. are very tame compared with animals on islands (e.g. Middle Doubtful) that are rarely visited by Man (cf. Ling and Walker 1976, 1977).

**TABLE 1**

Number of Sea lions counted on Carnac I. over 3 years.

Visit (one week)	Largest number counted during each visit
April/May 1975	27
June/July 1975	26
August 1975	25
September 1975	25
November 1975	30
August/September 1976	26
November 1976	32
January 1977	28

This long term study emphasizes that counts of seal populations made on short visits during the day to islands are likely to be unreliable. Moreover it brings into question the usefulness of making counts from an airplane or boat. King (1969) also acknowledges the unreliability of making counts of Fur seals based on brief visits. The only reliable method would be to camp on the breeding island for at least one week, at various times of the year (cf. Marlow 1968, Stirling 1971).

In January 1977, I tried to age the Sea lion population on Carnac I. All 27 animals were measured from snout to end of tail relative to my own height. Four large animals (one 2.6m long, three others 2.3m) were dark brown with a whitish/yellow cap, and were presumed to be adult males (King 1964). Fifteen animals were brown, but with white caps, and were presumed to be immature (?non-breeding) males (King 1964). Their measurements were: five animals 2.6m long, nine animals 2.3m long and one 2m long. The remaining eight animals were whitish ventrally and







FIG. 3: Habitat of Sea lions on Middle Doubtful Island. *Disphyma blackii* herbfield, elevation about 30 m above sea level.

All Fur seals were recorded either in the water, on boulder islets close to the island, or on the rocky shoreline close to the water's edge. Sea lions were mainly encountered away from the shore in small groups (31 out of 41 animals). Fur seals were never observed lying close enough to touch one another (except pups suckling from their mothers), whereas Sea lions were usually clumped together. Presumably, the Fur seal with its dense underfur and black or dark brown coat is likely to suffer heat stress readily and so has to remain near water, whereas the Sea lion (with a paler and less dense coat) is not often under heat stress and so can move inland on islands or rest in clumps (Gentry 1973).

That Sea lions can move well away from the water was apparently first noted on Rottne I. by Freycinet (1807). Over parts of Middle Doubtful I. the whitened old faeces of Sea lions were widely distributed. I recorded the distribution of these, and constructed (Fig. 2) a "dung-line" beyond which seals apparently did not venture. Sea lions did not go more than about 300m from where they hauled out (Fig. 2).

Fur seals appear to have no effect on island ecology, but Sea lions have a substantial effect. They haul out and make well defined tracks through the vegetation. The plateau of Middle Doubtful I. is covered with succulent herbfield dominated by

*Disphyma blackii*. Sea lions do not restrict themselves to the same few square metres each day, so that the vegetation there is little affected. On the sheltered side of the island, however, dense thickets of *Nitraria schoberi* (to 2m) occur. These have been tunnelled through by Sea lions, causing the bushes to take a humped-like arrangement. Ford (1965) found that *Nitraria* thickets on the islands with Sea lions between Dongara and Lancelin had a similar growth form. These islands are much smaller than Middle Doubtful, and Sea lions range completely over them. Ford (1963) considered that the compression of soil by seals and the opening up of the vegetation on islands used by seals had a deleterious effect on lizards.

## DISCUSSION

Marlow and King (1974) reviewed the past and present gross distributions of seals in Australian and New Zealand waters. The New Zealand Fur seal is, in New Zealand, increasing its numbers and occupying islands from which it was exterminated by sealers. It should prove interesting to monitor the distribution of the Fur seal in Western Australia to see whether and when it gradually occupies its original range. There is no evidence that this has happened to date.

Shaughnessy (1970) found that Fur seal populations from South and Western Australia were genetically similar (at one locus) to the same species of Fur seal in New Zealand. He suggested that Fur seals in South and Western Australia may have been exterminated by sealers, and that colonization has been from New Zealand. However, complete extermination of all Fur seal populations in Western Australia by sealers seems unlikely. Some of the granite islands off the southern coast of Western Australia are steep and dangerous to land on. Examples are Termination and Pearson Is. in the Archipelago of the Recherche. One wonders whether sealers on a quick landing from a whale boat as described by Clark (1842) could have killed and collected all individuals. This may explain why there are no Fur seals at present on the islands between Cape Leeuwin and Eclipse I. Nearly all of these islands have small coves, are inshore and are easily accessible. On the other hand, many of the islands in the Archipelago of the Recherche are steep-sided domes with black algal growth around them up to 10m above sea level.

That seals were widespread and conspicuous in the early days is apparent from there being five named Seal Islands and two Seal rocks off the coastline of Western Australia. These are located in Houtman Abrolhos (now called Long I.), near Jurien Bay (now called Sandland I.), near Perth, off Cape Leeuwin, in King George Sound, and the two Seal rocks are in Doubtful Island Bay and in the Archipelago of the Recherche.

The only island populations in which I observed Fur seal pups were on Eclipse I. (April 1975), Middle Doubtful I. (March 1977) and Salisbury I. (April 1977). Sea



lion pups were found only on Middle Doubtful I. (March 1977). At these times, adult males showed no overt aggression to me, so presumably breeding on these islands takes place at the times recorded for other islands by Marlow (1968) and Stirling (1971, 1972). Stirling found that Fur seals bred in November-January and Sea lions in October on the South Neptune Islands, South Australia. Sea lions also breed in October on Dangerous Reef, South Australia (Marlow 1968). However, in 1975 Ling and Walker (1976, 1977) found new-born Sea lion pups on Kangaroo I. between February and October. In addition, on Fisherman Is., Western Australia, R.E. Johnstone (pers. comm., and in Chapman and Kitchener 1977) has found new-born Sea lion pups present at all times of the year.

The total size of current Western Australian populations of the Fur seal (about 400-500) compares favourably with the 500 animals recently recorded for South Australia (Ling and Walker 1977). However, these authors report a total population size of the Sea lion in South Australia of about 2,300 animals, over three times as many animals as in Western Australia. Why this should be so is unclear.

Middle Doubtful Island, with a large population of both pinniped species, is easily accessible from Bremer Bay. It would be a suitable island on which to study in detail the local biology of both species, so that comparisons with recent studies on South Neptune I., Kangaroo I., and Dangerous Reef (South Australia) could be made.

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## THE *DIPLODACTYLUS VITTATUS* COMPLEX (LACERTILIA, GEKKONIDAE) IN WESTERN AUSTRALIA

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### ABSTRACT

Three species occur in Western Australia: *D. ornatus* Gray, *D. polyophthalmus* Günther and *D. granariensis* nov. The last-named species extends to western South Australia; further east it is replaced successively by *D. furcosus* Peters and *D. vittatus* Gray.

### INTRODUCTION

Kluge (1967) combined all the forms of the complex into a single taxon, *D. vittatus*. King (1977) questioned this arrangement, suggesting that the complex consisted of five species. After examining all the material in the Western Australian Museum and some specimens in the Australian Museum, I agree broadly with King but differ in the allocation of certain populations.

Because of sympatry without hybridization, it is clear that three species occur in Western Australia. The west-coastal species (the northwestern segment of King's chromosomal race " $2n = 38$  WA A") is *D. ornatus*. The spotted gecko of the Darling Range (King's " $2n = 38$  WA B") is *D. polyophthalmus*. The species centred on the Western Australian Wheat Belt is herein named *D. granariensis*; it consists of King's " $2n = 36$  WA" plus the southeastern segment of his " $2n = 38$  WA A" and that part of his " $2n = 38$  EA" from west of Spencer Gulf.

At first I thought the name *vittatus* could be applied to the Wheat Belt species. However the type of *vittatus* does not agree with any western population and was almost certainly collected by Allan Cunningham during his expedition from the

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Hunter River to the Darling Downs in 1827. At any rate, Kluge's restriction of the type locality to the Darling Range was invalid, for Cunningham never visited that part of Western Australia.

I am grateful to Mr A.F. Stimson of the British Museum (Natural History) for the loan of the holotype of *D. vittatus* (registered number 1946.9.7.43), the lectotype of *D. polyophthalmus* (67.2.19.16) and the holotype of *D. ornatus* (1946.9.7.26). The last specimen was figured by Gray (1867, pl. 16, fig. 2).

### *DIPLODACTYLUS ORNATUS*

*Diplodactylus ornatus* Gray, 1845, Catalogue of the specimens of lizards in the collection of the British Museum, p.149. "Houtman's Abrolhos" (J. Gilbert) [probably in error for Champion Bay, W.A.].

#### **Diagnosis**

A medium-sized long-tailed member of the complex with ocellate flanks and pale, dark-edged vertebral stripe. Further distinguishable from sympatric *D. granariensis* by longer snout, lower head, much smaller anterior supranasals (less than half as high as rostral and usually separated), smaller posterior supranasals (separated in 76% of specimens by more than 4 granules), higher first labial, darker lips, mental (usually wider than high), and wider subdigital lamellae.

#### **Distribution**

West-coastal dunes and near-coastal sandplains of Western Australia from Exmouth Gulf south to Jurien Bay and inland to East Yuna and Coorow.

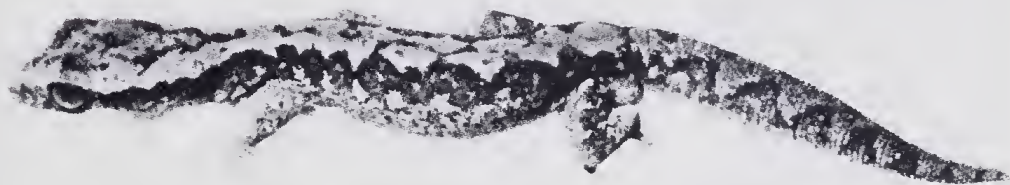
#### **Description**

Snout-vent length (mm): 21-58 (N 79, mean 47.1). Length of tail (% SVL): 62-80 (N 36, mean 69.2).

Rostral quadrangular with upper side more or less arched, 1.8-3.1 times as wide as high (N 74, mean 2.39), median groove extending down for 10-55% of scale (N 74, mean 39). Nostril surrounded by first labial, rostral, 2 supranasals and 3-6 postnasals (usually 4, N 77, mean 4.1). Anterior supranasals less than half as high as rostral (N 78) and separated by one (38%), two (36%) or three granules (17%), or in short (6%) or moderately long contact (3%). Posterior supranasals small and separated by 3-7 granules (N 77, mean 5.1). Upper labials 8-11 (N 79, mean 9.2) back to middle of eye. Mental 0.8-1.3 times as wide as high (N 79, mean 0.94). First lower labial 1.2-1.9 (N 46, mean 1.59) times as high as wide. Anterior lower labials gradually decreasing in size. Subdigital apical plates moderately large, separated on

fourth toe by 2 or 3 (rarely 4) rows of granules from 2-5 wide lamellae (N 66, mean 3.8) tending to be dumbbell-shaped and usually well differentiated from 1-6 (N 66, mean 3.9) rows of circular scales on base of toe. Cloacal spur comprising 3-9 large pointed scales (N 36, mean 6.1).

Dorsal and lateral ground colour dark grey or greyish brown. Bold pale grey or pale brown vertebral stripe, bifurcating on nape before passing forward above temples and canthus rostralis; margins of stripe shallowly serrate to deeply sinuous on back, and deeply to very deeply sinuous on tail. Lower edge of vertebral stripe black or blackish brown, continuing forward on side of head as dark loreal stripe. Upper lips partly or wholly dark. Under limbs and tail spotted dark grey (spots coincident with whole granules); under digits dark grey; rest of under surface whitish, each granule bearing a dark central dot.



**Plate 1.** A *Diplodactylus ornatus* from the Marchagee Reserve, photographed in life by Mr T.M.S. Hanlon.

### **Geographic variation**

Northern geckos (Exmouth Gulf to Shark Bay) are small (maximum snout-vent length 50 mm).

### **Material**

North-west Division (W.A.): Learmouth (11515); Maud Landing, Cardabia (15243); Quobba (13436*a* and *b*); Dirk Hartog I. (42338, 44543, 45818-9); False Entrance Well, Carrarang (39027, 54827, 55193-4); Baudin I. (25686); 10 km NE of Denham (54828-30); Denham (49987); 8 km SE of Nanga (54850-1).



Fig. 1. Map of south-western Western Australia showing location of specimens of *Diplodactylus ornatus* and *D. polyophthalmus*.



South-west Division (W.A.): Kalbarri National Park, including Mt Curious, The Loop, Junga Dam, Four-ways, 18 km S of Kalbarri and 30 km NNW of Ajana (33459, 33598, 33630-1, 33664, 33704, 33752, 33870, 33936-7); Balline (13551); 28 km NE of Yuna (57518); East Yuna Reserve, 50 km ESE of Yuna (48078, 48083, 48243-4, 48246-7, 48251, 49917, 56999-57001); Bindoo Hill Reserve, 33 km N of Tenindewa (48062, 48204); Geraldton (51187); Beagle Point (19754); 13 km SW of Eneabba (22238); Marchagee Reserve, 10 km S of Coorow (49989, 57604-5, 57755, 57776-9); Green Head (57592); 2 km W of Mt Peron (49124); 5 km W of Padbury (48452, 48469, 48489-94, 49099); 6 km S of Padbury (48514); Mt Lesueur (49124); 9 km NE of Jurien Bay (46562-5); Jurien Bay (26665).

### *DIPLODACTYLUS POLYOPHTHALMUS*

*Diplodactylus polyopthalmus* Günther, 1867, Ann. Mag. nat. Hist. (3)20:49. Nickol Bay and Champion Bay, W.A. (Duboulay). [Kluge (1967: 1035) designated the "Champion Bay" specimen as lectotype after discovering that the Nickol Bay specimen was a *D. stenodactylus*.]

#### **Diagnosis**

A small flat-headed member of the complex with relatively short thick tail and with colour pattern consisting mainly of pale reddish brown spots on a dark reddish brown ground (i.e., there are no bold dark-edged pale vertebral stripe or dark-edged pale dorsal blotches, and there is no black or blackish brown on back and sides). In northern Darling Range easily distinguished from sympatric *D. granariensis* by coloration, lesser size, thicker tail, longer snout, lower head, smaller supranasals, more postnasals, higher and wider first upper labial, lower mental and first lower labial, and sharp decrease in size between second and third lower labials. In the south of their common range, differences between the two species are generally reduced.

#### **Distribution**

Humid southwest of Western Australia from Cockleshell Gully south-southeast through the Darling Range to the Stirling Range.

#### **Description**

Snout-vent length (mm): 23-56 (N 91, mean 43.7). Length of tail (% SVL): 49-69 (N 27, mean 58.2).

Rostral quadrangular with upper side more or less arched, 1.8-3.0 times as wide as high (N 79, mean 2.26); median groove extending down for 10-65% of scale (N 72, mean 39). Nostril surrounded by first labial, rostral, 2 supranasals and 3-6

postnasals (usually 4 or 5, N 81, mean 4.6). Anterior supranasal up to half as high as rostral (N 91), in short (36%) or moderately long (31%) contact with its opposite number or separated by a granule (29%). Posterior supranasals small and separated by 2-6 granules (N 85, mean 4.3). Upper labials 8-11 (N 84, mean 9.1) back to middle of eye, first usually higher than second. Mental 0.8-1.4 times as high as wide (N 86, mean 0.98). First lower labial 0.8-1.8 times as high as wide (N 31, mean 1.31). Third lower labial usually markedly smaller than second. Subdigital apical plates moderately large, separated on fourth toe by 2 or 3 (rarely 4) rows of granules from a median series of 2-5 (N 57, mean 3.6) moderately large, circular lamellae, not strongly differentiated from 3-8 (N 57, mean 4.6) rows of smaller circular scales on base of toe. Cloacal spur comprising 5-13 long pointed scales (N 29, mean 8.7).

Dorsally and laterally dark reddish brown, spotted with pale reddish brown. Spots on head, back and tail larger, less circular and often less sharply defined than those on sides; paravertebral spots of one side often confluent with those of other side to form transversely or obliquely elongate blotches; dorsal spots occasionally so large as to leave only a reticulum of ground colour. Lateral ground colour continuing forward as a dark stripe through temples and orbit to lores. Upper lips dark. Under surfaces white, each granule bearing a dark central dot.



**Plate 2.** A *Diplodactylus polyophthalmus* from Mt Dale, photographed in life by Mr T.M.S. Hanlon.

## Geographical variation

Specimens from the Tuart belt of the northern Swan Coastal Plain (Yanchep to Kings Park) are considerably larger than those from elsewhere (SVL 30-56 mm, N 8, mean 47.7; vs 23-52, 82, 43.2). This apparently isolated population also differs in having more granules between the posterior supranasals (4-6, N 8, mean 5.4; vs 1-6, 77, 4.1). In the far northern population (Cockleshell Gully) the tail is longer than elsewhere (59-69% of SVL, N 4, mean 65; vs 49-65, 28, 57); this seems to be an isolated population too.

## Remarks

The lowest of the three specimens from Darlington photographed by Kluge (1967, pl. 1, fig. 1) is a *D. polyophthalmus*; the others are *D. granariensis*.

## Material

South-west Division (W.A.): 4 km NW of Mt Peron (49049); 5 km W of Padbury (49098); Mt Lesueur (11169-70, 48434); 8 km S of Yanchep (15244); Wanneroo (26856-7); Kings Park (3327, 15246-9); Forrestfield (19368); East Victoria Park (11484); Maddington (388); W of Northam (11256); Noble Falls (21829); Parkerville (39165-6); Mundaring district (14538, 14851-3, 15022, 16518-9, 19655, 20592, 24090, 26444, 39649, 49956); Zamia (21341); Darlington (21261); Stathams (5998, 6000); Gooseberry Hill (2838, 4493, 4671-3); Kalamunda (2978, 15208); 8 km E of Kalamunda (57603); Lesmurdie (15250); ridge E of Seaforth (15251); Kelmscott (51425, 51427-8); Roleystone (15252-3); Karragullen (1420, 15254-5); 25 km SE of Karragullen (15256); Mt Dale (49713, 57602); Ashendon (39643, 39650); Canning Dam (54245-7); 3 km SE of Armadale (51188); Gleneagle (32469); 7 km E of Jarrahdale (19367); Serpentine (2340-1, 13656, 54248); Banksiadale (6794); Mt William (57316); Williams (4709-10); 25 km W of Collie (49253-5); Boyup Brook (3412); Manjimup (5606); between the upper reaches of the Perup and Tone Rivers (42553); Tolls Pass, Stirling Range (1995).

## *DIPLODACTYLUS GRANARIENSIS* SP. NOV.

## Holotype

R54239 is Western Australian Museum, collected by R.B. Humphries on 10 August 1973 at Walyahmoning Rock, W.A., in 30°38'S, 118°43'E, and karyotyped by M. King.

## Diagnosis

A moderately large, thin-tailed member of the complex with short snout, deep head, pale lips and a pale, dark-edged vertebral stripe bifurcating on nape (regional-

ly broken up on back and tail into angular, kidney-shaped, circular, amoeboid or lens-shaped blotches). Further distinguishable from sympatric *ornatus* by lack of lateral ocelli, much larger supranasals (anterior more than half as high as rostral and almost invariably in median contact; posterior much larger than postnasals and seldom separated by more than four granules), lower and narrower first upper labial, and mental usually higher than wide. Further distinguishable from sympatric *polyophthalmus* by lower and narrower first upper labial, gradual decrease in size in anterior lower labials (rather than sharp decrease between second and third) and wider subdigital lamellae (distally tending to be elliptic rather than circular).

### **Distribution**

Southern Western Australia; north to the Hutt River, East Yuna, nearly to Mt Jackson (Pigeon Rocks), Comet Vale, Queen Victoria Spring and the northern edge of the Nullarbor Plain; and south and west to a line through Jurien Bay, Moolia-beenee, the Darling Range, Collic, Kojonup, the Stirling Range and the Fitzgerald River. Extra-limital in western and southern Eyre Peninsula (S.A.). A different and apparently isolated population in the Wiluna district.

### **Description**

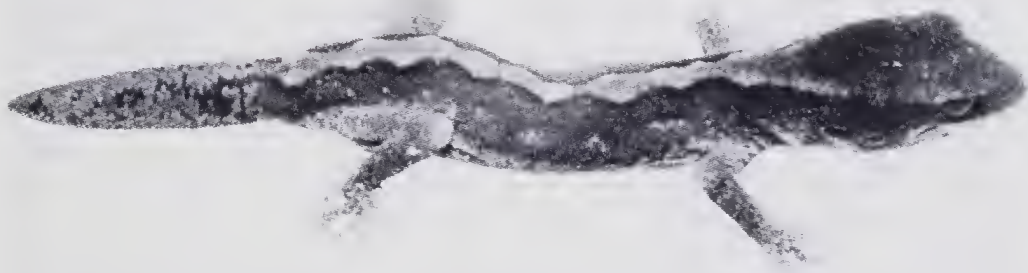
Snout-vent length (mm): 25-62 (N 308, mean 48.6). Length of tail (% SVL): 51-78 (N 170, mean 65.1).

Rostral quadrangular with upper side more or less arched, 1.9-3.4 times as wide as high (N 218, mean 2.43); median groove extending down for 0-70% of scale (N 218, mean 29). Nostril surrounded by first labial, rostral (almost invariably), prenasal (very rarely), 2 supranasals and 2-5 postnasals (mostly 3 or 4, N 283, mean 3.3). Anterior supranasals half or more as high as rostral (N 298) and in long (48%), moderately long (37%) or short contact (10%), or separated by one (4%) or two granules (1%). Posterior supranasals moderately large and separated by 1-7 granules (mostly 2-4, N 295, mean 3.0). Upper labials 7-12 (N 278, mean 8.9) back to middle of eye, first usually a little lower and narrower than second. Mental 0.8-1.7 times as high as wide (N 246, mean 1.09). First lower labial 1.0-2.3 times as high as wide (N 229, mean 1.68). Anterior lower labials gradually decreasing in size backwards. Subdigital apical plates moderately large, separated on fourth toe by 2 or 3 (rarely 4, very rarely 5) rows of granules from a median series of 1-9 (N 197, mean 4.5) moderately large circular or transversely elliptic lamellae, often poorly differentiated from 0-7 (N 195, mean 3.3) rows of smaller circular scales on base of toe. Cloacal spur comprising 4-14 long pointed scales (N 82, mean 7.9).

Dorsal and lateral ground colour greyish brown. In northern inland parts of range a bold greyish white, brownish white or pale brown vertebral stripe, bifurcating on nape as it passes forward above temples; margins of stripe on back and tail nearly straight or shallowly to deeply sinuous or serrate; stripe edged below with blackish



brown; pale lateral spots seldom present and never black-edged; blackish lower lateral spots often present (apparently remnants of lower margin of pale sinuous midlateral stripe); lips usually white and contrasting strongly with darker coloration of face; rest of under surface white, granules with or without a dark central dot. Towards coasts and in southern interior vertebral stripe becoming increasingly irregular and broken; pale spotting on flanks increasing; and blackish lower lateral spots disappearing.



**Plate 3.** A *Diplodactylus granariensis* from the Brookton Highway 54 km ESE of Kelmscott, photographed in life by Mr T.M.S. Hanlon.

### **Geographic variation**

The vertebral stripe in the northern inland parts of range (west to East Yuna, Marchagee, New Norcia and Darlington, and south to Narrogin, Kondinin, Mt Holland, Newman Rocks and Frazer Range), though becoming increasingly indented southwards, is seldom broken. Further south (north to Collie, North Tarin Rock, Lake Varley, Salmon Gums, Caiguna and Eucla) the vertebral stripe is usually broken up into a highly variable series of blotches. Concurrently with these clinal changes in pattern, the body becomes shorter, the head less deep, the supranasals smaller, the postnasals more numerous, the mental lower and the lips darker; and according to King (1977) the diploid chromosome number increases from 36 to 38. All these changes are in the direction of *D. polyophthalmus*, so that at their southern limit in the Stirling Range the two species are not easily separated.



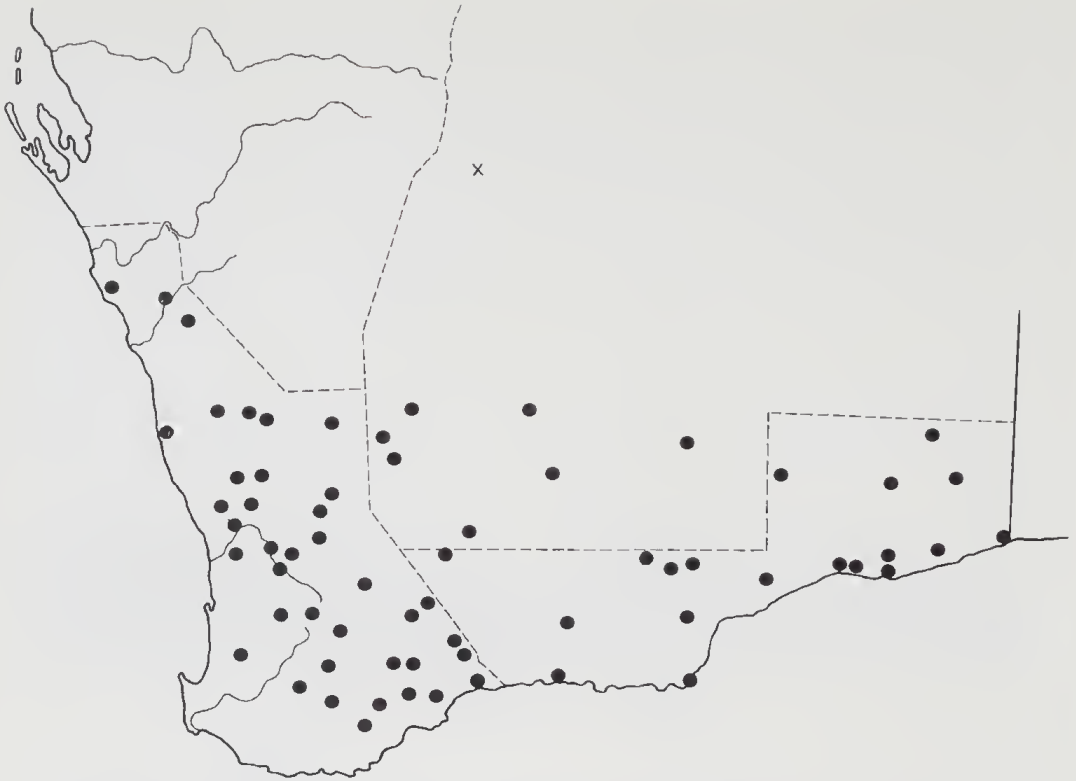


Fig. 2. Map of southern Western Australia showing location of specimens of *Diplodactylus granariensis*. Cross indicates location of peculiar specimen from Wiluna.

On the west coast, from the Hutt River south to Jurien Bay and inland to Moolia-beenee, the vertebral stripe is deeply sinuous or broken up into blotches. In all other respects these geckos agree with those of the northern interior rather than with the superficially similar southern populations.

In October 1977 Mr J.C. Wombey of CSIRO Wildlife Research collected a *granariensis* at 13 km E of Wiluna, i.e. nearly 500 km NE of the mulga-eucalypt line. This specimen is remarkable for its great size (SVL 69 mm), very wide ungrooved rostral, and narrow vertebral stripe with almost straight margins; it is located on map (Fig. 1) by a cross. West of the Nullarbor Plain typical *granariensis* extends inland only to the mulga-eucalypt line.

Our specimens from Elliston (25977-26000) and Port Neill (27339-42), Eyre Peninsula, are similar to *granariensis* from southern Western Australia.

Our specimens from the Flinders Ranges east of Port Augusta (55760-3) are fairly similar to *granariensis*. They have a short snout, very deep head, large supranasals and low first upper labial, but the tail is much shorter (45, 47 and 57% of SVL).

According to King (1977) this population has  $2N = 34$  chromosomes; it probably represents a full species, *D. furcosus* Peters.

Eleven specimens from southeastern Queensland and eastern New South Wales, kindly loaned by Dr A.E. Greer of the Australian Museum, are more like *ornatus* than *granariensis*. The head is low, the first upper labial higher than the second, the mental usually lower than wide, and the flanks are often dark, spotted with white. However the tail is much shorter (50-59% of SVL,  $N = 8$ ), and in all but one specimen the anterior supranasals are contiguous. I believe that the type of *D. vittatus* Gray came from this population.

### Paratypes

South-west Division (W.A.): 12 km E of mouth of Hutt River (27397-9); East Yuna Nature Reserve, 50 km ESE of Yuna (48084, 48087, 48245, 56997-8); Wilroy Reserve, 19 km S of Mullewa (57642, 57648, 57650-2, 57658-9, 57671-3, 57675-7, 57681-2, 57685); Buntine (43612-5, 43622-6); Marchagee Reserve, 10 km S of Coorow (57775); 8 km NE of Mt Peron (25286-7); 4 km E of Mt Peron (49002-3, 49015, 49021-3); 5 km W of Padbury (49100); 25 km E of Jurien Bay (22277); 26 km NE of Dalwallinu (57892-6); 20 km NE of Dalwallinu (57867-79, 57897-906); 12 km NE of Dalwallinu (51109-10, 51112-6, 57880-91); 48 km N of Beacon (48312-3, 48333, 48356); Wongan Hills (50245); 11 km NE of New Norcia (25674, 26859); Trayning Reserve, 11 km E of Kununoppin (45967-70, 46138, 46321-2, 46330, 46333, 46355-8); 17 km NW of Kellerberrin (52360-1); Yorkrakine Rock (52316); 13 km W of Bolgart (27395-6); Mooliabeenee (3323); Lower Chittering (40230); Culham (15245); 25 km SW of Toodyay (22842-3); "Wanneroo" (26858); Chidlows (54240); Darlington (15249); Boya (29288); ridge E of Seaforth (15292); York (54250); 3 km NW of Beverley (50007); 5 km SW of Mawson (50005-6); 21 km NE of Quairading (52208-15, 52401-2); 8 km NE of Bendering (52565-70); Bendering (43427); Dryandra (31948); 25 km E of Yornaning ( $32^{\circ}45'S$ ,  $117^{\circ}22'E$ ) (50208-15, 51334-40); Lake Varley (19808-9, 28951, 29046); Dragon Rocks Reserve (42977); 11 km NW of Dragon Rocks (42991); Dongolocking Reserve ( $33^{\circ}02'S$ ,  $117^{\circ}43'E$ ) (49578-81, 49585-7, 49758-9); North Tarin Rock Reserve (40060, 40084, 44423); 11 km W of Darkan (26005); Collie (1958); Kojonup (22849); 10 km E of Woodanilling (23349); Greenshields Soak, 28 km E of Pingrup (39842-3, 39881, 39886, 39918-21); Lake Magenta Reserve, including Sullivans Soak and 48 km E of Pingrup (39902, 43000-1, 43006, 43985, 45306); 32 km NNE of Ravensthorpe (47624); 8 km N of Ravensthorpe (30827-8); 8 km N of Hopetoun (55934); middle Fitzgerald River (36008, 36787-90, 36873, 36935, 36952-3); Jerramongup (15257-8); Ongerup (54244); 10 km SE of Ongerup (42616); 87 km N of Mt Barker (54242); Chester Pass, Stirling Range (17867-8).

Eastern Division (W.A.): Pigeon Rocks (36435); 52 km NNE of Bonnie Rock (57040); Walyahmoning Rock (41180-1, 54241, 54243); Comet Vale (26384); Queen Victoria Spring (48056); Kalgoorlie (20607); 48 km S of Karalee (33955).

Eucla Division (W.A.): Split Rock, 30 km N of Mt Holland (37821); Newman Rocks (15263-4, 53438-43); 13 km E of Frazer Range (30751-5); Salmon Gums (30789); Dalyup River (12259-60); Point Malcolm (37732); Coragina Rock (15261-2); 33 km N of Balladonia Hotel (29472); 21 km E of Balladonia (53345-7); 36 km NW of Rawlinna (41211, 41629); Seemore Downs (15999); 80 km NE of Rawlinna (41194-7); 40 km W of Caiguna (31894); S of Caiguna (28153); 8-14 km SE of Cocklebiddy (24663-7, 27369, 31892, 53375-86, 53418, 54249); Roe Plains, 25 km ESE of Cocklebiddy (34451-61); Loongana (29173); 100 km NE of Loongana (41625); Forrest (26029); Madura (24652); 20 km S of Madura (34485); 45 km S of Madura (34439-41); Mundrabilla (25514); Eucla (24601-2).

### Postscript

Through the courtesy of Mr Wombey, I have recently examined a specimen of *D. granariensis* in his collection from Mooloogool, 80 km NE of Meekatharra. This specimen scarcely differs from those of the northern Wheat Belt, which indicates that the species is widely (if sparsely) distributed north of the mulga-eucalypt line.

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## DERMANYSSINE MITES FROM AUSTRALIAN BIRDS<sup>1</sup>

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### ABSTRACT

*Liponyssoides lukoschusi* sp. nov. is the first Australian representative of this widespread genus – hosts *Podargus strigoides* (Latham) (Podargidae) (Western Australia) and *Climacteris picumnus* Temminck (Certhiidae) (Queensland). *Dermanyssus hirundinis* (Hermann) is confirmed as a member of the Australian fauna – hosts *Meliphaga flavicollis* (Vieillot) (Meliphagidae) (Tasmania) and possibly *Hylochelidon ariel* (Gould) (Hirundinidae) (Western Australia).

### INTRODUCTION

This contribution to the ectoparasites of Western Australia collected by Dr F.S. Lukoschus, Catholic University, Nijmegen, largely concerns a new species of *Liponyssoides* Hirst from a frogmouth. This bird is also host to other interesting mite parasites: *Oxleya* Domrow, 1965 (Epidermoptidae: Turbinoptinae), *Boyardia podargi* Fain & Lukoschus, 1979 (Ereynetidae: Speleognathinae) and *Caprimuldecetes* Janssen Duijghuijsen, Lukoschus & Fain, 1979 (Hypoderidae).

In addition, the presence of *Dermanyssus hirundinis* (Hermann) on native Australian birds is confirmed. The only other dermanyssine known from Australia is *D. gallinae* (De Geer), a widespread pest of poultry, see Domrow (1963).

The term “holotrichous” refers to the setal condition in typical free-living dermanyssids (Evans & Till 1965, Evans 1969). Hosts are after Leach (1958). Depositories are abbreviated: WAM Western Australian Museum, Perth; FMNH Field Museum of Natural History, Chicago; QIMR Queensland Institute of Medical Research, Brisbane; CU Catholic University, Nijmegen.

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1. Results of Western Australian Field Programme 1976-1977, Field Museum of Natural History, Chicago, and Western Australian Museum, Perth. Aided in part by Grant R 87-111 from Netherlands Organisation for Advancement of Pure Research (Z.W.O.), The Hague. Miss Cobie Rudd prepared the illustrations.

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*Liponyssoides lukoschusi* sp. nov.

Traditionally, the Dermanyssinae comprised three genera: *Dermanyssus* De Geer, *Liponyssoides* Hirst and *Allodermanyssus* Ewing [see Strandtmann & Wharton (1958)], but more recent opinion on their inter-relationships has varied. Thus, Krantz (1959) sunk *Allodermanyssus* under *Dermanyssus*, since both included species with a fragmented dorsal shield; while Sheals (1962) and Moss (1967) indicated that *Allodermanyssus* was a synonym of *Liponyssoides*, on setal characteristics. The latter position is accepted below.

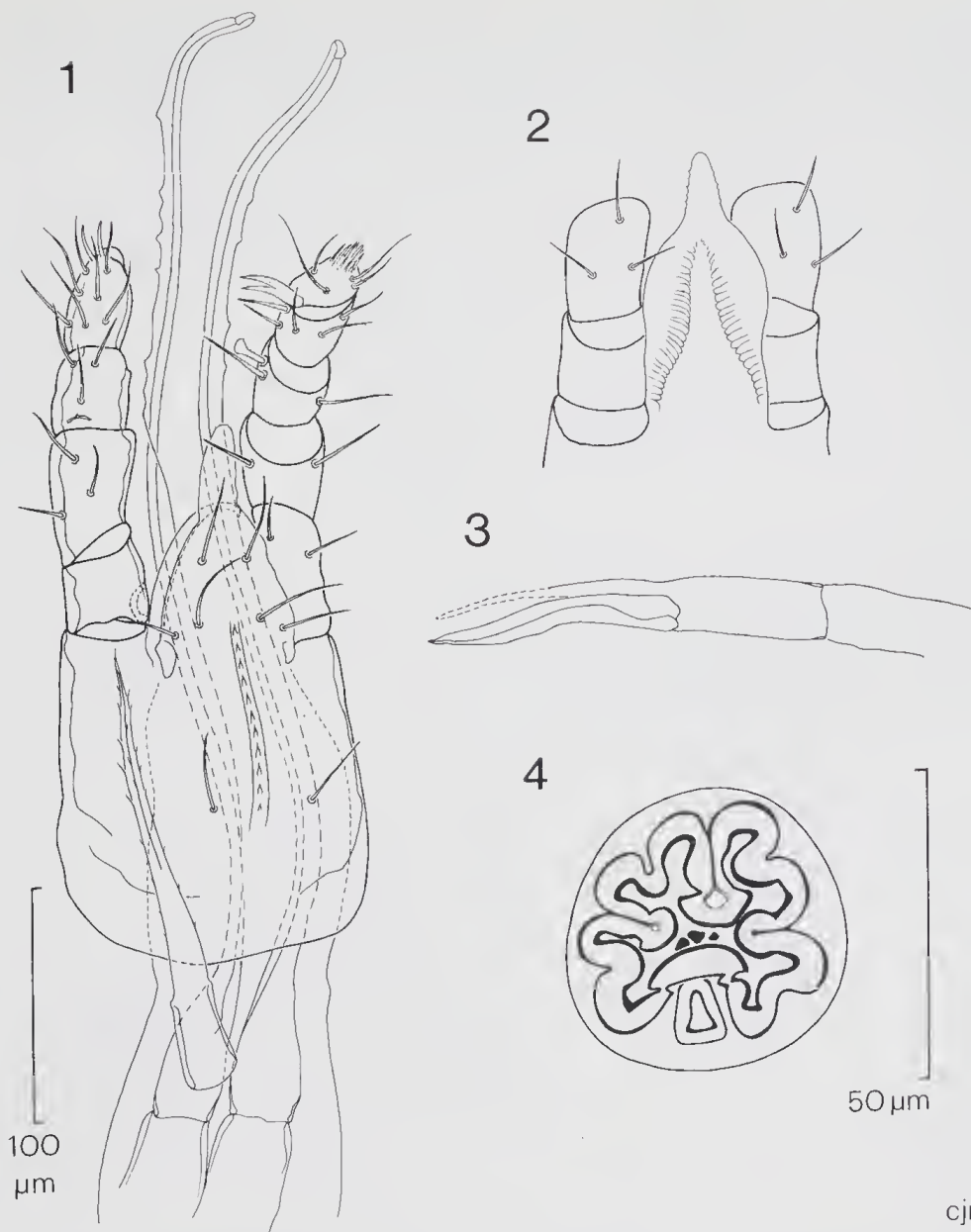
In this context, *Liponyssoides* includes eight valid species: *L. lukoschusi* (the new species); *L. muris* (Hirst) [= *L. murinus* (Oudemans), see Strandtmann (1963)] and *L. brasiliensis* (da Fonseca) [these two possibly conspecific, the former redescribed by Domrow (1963)]; *L. becki* (Allred) [reassigned by Nelson & Furman (1967)]; *L. intermedius* (Evans & Till) and *L. warnekei* Domrow [these two from swiftlets (Apodiformes: Apodidae)]; and *L. aegyptius* (Hirst) and *L. sanguineus* (Hirst) [these two originally in *Allodermanyssus*, and clarified by Costa (1961)].

The female of the new species closely resembles that of *L. muris*, except in the shape of the sternal shield and the position of setae  $st_3$  (Hirst 1914), but the male is at once separable by the structure of the two enormous pores on the dorsal shield [cf. Fig. 4 below and Fig. 31 in Domrow (1963)], and the number of pairs of setae on the dorsal shield (28 vs 32).

The new species is named for Dr Lukoschus – the care with which he made his large collection from the Kimberley will be the more obvious when it is all in print. **Female (Figs 1-2, 5-6):** Capitulum as in *L. warnekei* Domrow, 1963, except as follows. Setae  $c$  exceeding opposite edge of deutosternum (but not quite as long as interval), a little longer than  $h_2$  and a little shorter than  $h_1, 3$ . Distinct, inwardly curved salivary stylets present (as they are in *L. warnekei*); epistome (when clearly seen) hyaline, broad in basal two-thirds, then strongly tapered, with drawn-out tip deflexed and exceeding bases of palpal genua; with elongate dendritic pattern basally. Inner face of palpal trochanter with crescentic basal apodeme, cf. *Eulaelaps* Berlese (Domrow 1960). Palpal setation holotrichous (as it is in *L. warnekei*); trochanter 2 ( $v_2$  not unduly lengthened), femur 5, genu 6 ( $al_1$  strongly clavate; dorsobasal pore present as it is in *L. warnekei*), tibia 14 (including two dorsodistal rods), tarsus with a few setae (plus terminal cluster of rods). All setae on capitulum simple, lacking minute barbules along their shaft. Chelicerae about 530  $\mu$ m long overall.

Idiosomatal measurements unavailable since all specimens were grossly engorged, and ruptured during mounting procedures. Dorsal shield entire, almost parallel-sided in anterior two-thirds, then tapered to rounded posterior margin; 800-900  $\mu$ m long, 350-390  $\mu$ m wide at humeri; with 20 pairs of setae (14 podonotal, six



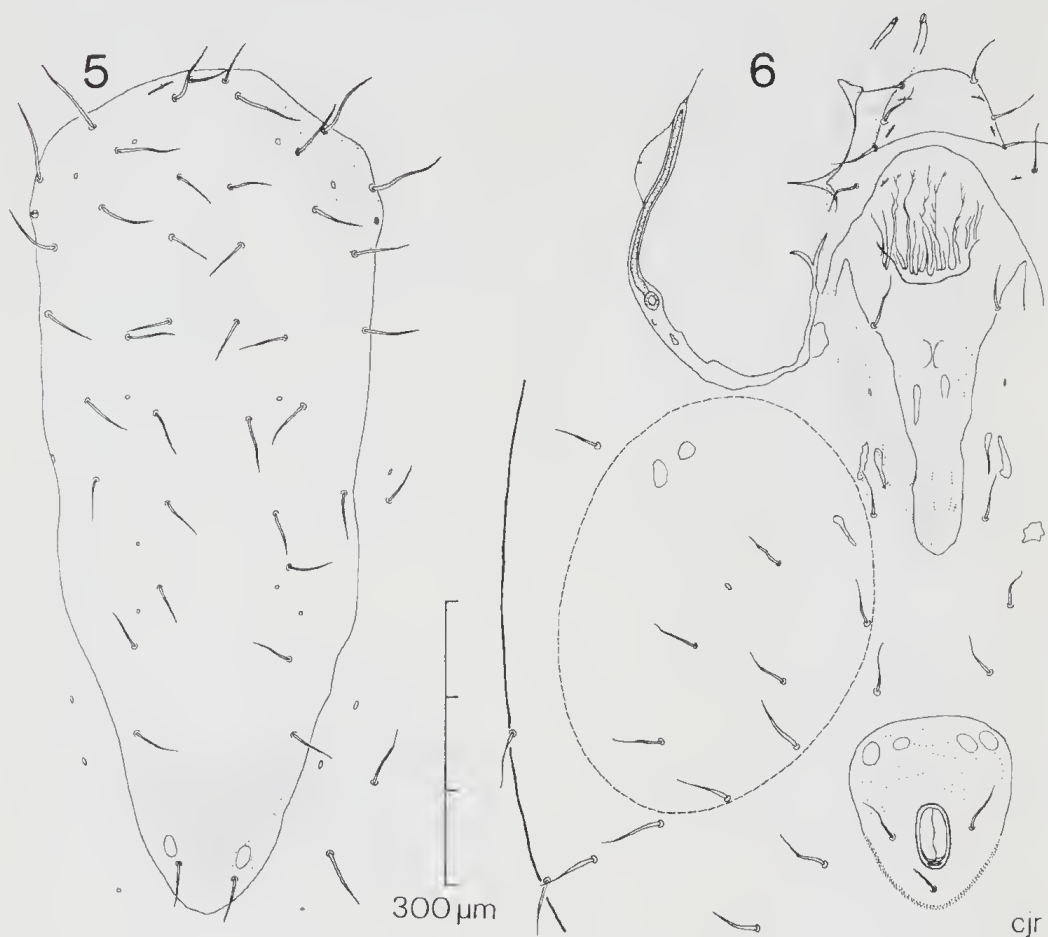


cjr

**Figs 1-4:** *Liponyssoides lukoschusi* sp. nov. 1, Capitulum and tritosternum ♀ (ventral, but true right palp dorsal). 2, Epistome ♀ (dorsal). 3, Chelicera ♂ (ventroexternal). 4, Enormous pore on dorsal shield ♂.

opisthonotal;  $z_6$  absent on one side of one specimen,  $Z_1$  occasionally absent on one or both sides); surface with reticulate pattern, paired muscle insertions and about seven pairs of pores (including an elongate pair vertically and a large pair humerally). Dorsal cuticle torn and not fully drawn, but with pair of large pores

posterolaterally as in ♂ (Fig. 7), several pairs of small pores following line of cuticular striae (of which one or more of four pairs shown posterolaterally in Fig. 5 may be usurped by shield), and many setae. Setae on dorsum with one to three minute barbules along their shaft, depending on their length.



Figs 5-6: *Liponyssoides lukoschusi* sp. nov., ♀ (most of cuticle omitted). 5, Dorsum. 6, Venter.

Tritosternal base unarmed; laciniae fused at least in basal half, lightly ciliated. Sternal shield 65µm long in midline, 120µm wide at setae  $st_2$ ; virtually textureless; with setae  $st_{1-3}$  submarginal (lattermost in extreme posterior angles) and two pairs of pores. Setae *mst* and associated pores free in cuticle. Genital shield strongly tapered behind coxae IV, flanked by three pairs of irregular shieldlets; surface marked by muscle insertions and generally longitudinal reticulations; length 400-430µm (including operculum), width 120-130µm between setae *g* (associated pores free in cuti-

cle); weak genital apodemes present between coxae IV, supporting operculum whose rays arise from distinct convex line. Undifferentiated egg broadly ovate, textureless; 450-530 $\mu$ m long, 335-385 $\mu$ m wide. Anal shield 185-200 $\mu$ m long, 140-170 $\mu$ m wide; broadly rounded anterolaterally, usurping one ventral seta in one specimen; surface marked by muscle insertions and generally concentric reticulations; narrow cribrum present; anus set in smaller posterior half, flanked by setae *aa* and *pa* (latter the shortest). Two pairs of barely joined endopodal shields present. Two pairs of metapodal shields present. Ventral cuticle with numerous setae of increasing length posteriorly and some small paired pores. Setae on venter simple, except larger ones posterolaterally on cuticle, which bear one to three minute barbules along their shaft. Stigmata giving rise to peritremes that reach forward to level of middle of coxae II; peritrematal shields with distinct pores behind stigmata and on anterior expansion, fused posteriorly to exopodal shields IV.

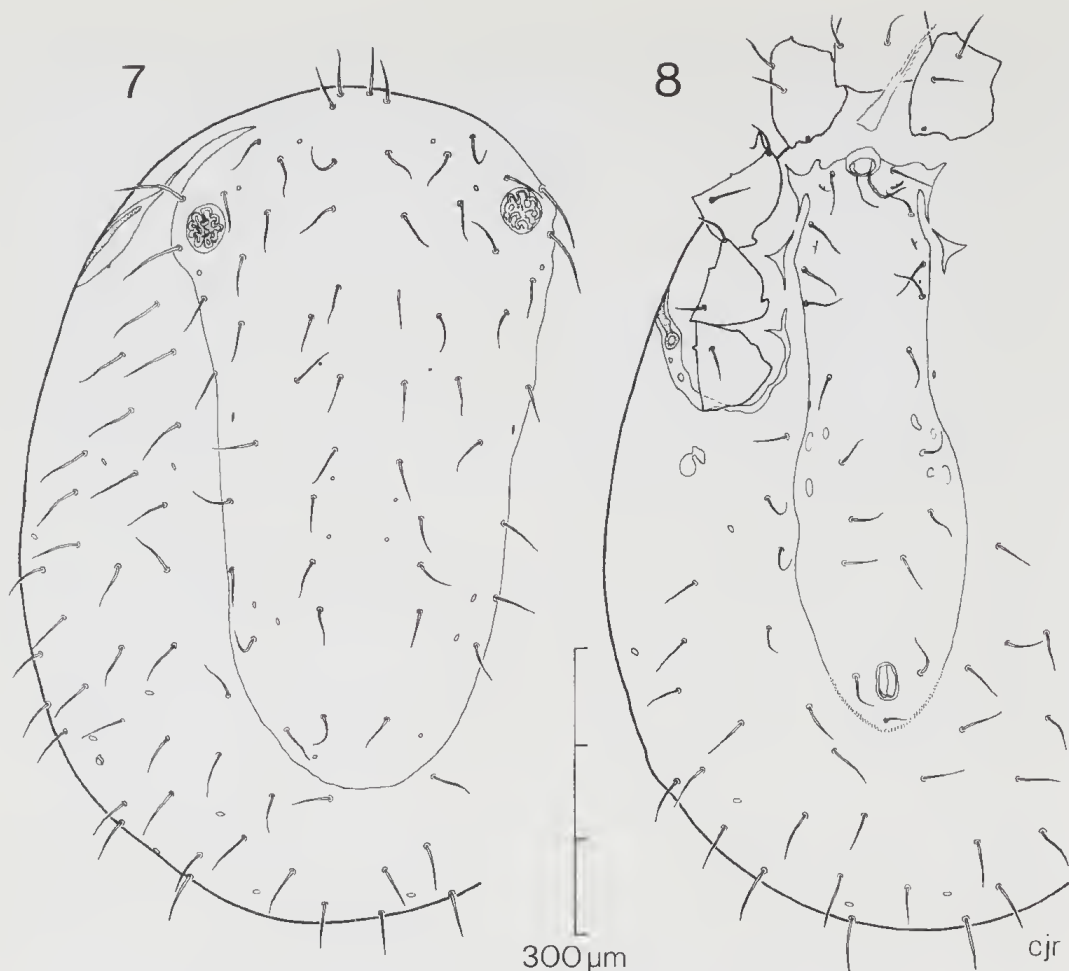
Legs with same setational formulae as in *L. warnekei* and *L. intermedius* (Evans & Till, 1964), i.e. holotrichous, except that genu-tibia III bear one additional seta (*pl*<sub>2</sub>), being 2-4/2-2 and 2-3/2-2, respectively. Weaker setae simple, but stronger ones with one to three minute barbules along their shaft. No setae on femora-genua I-II unduly lengthened. Sensory islet on tarsus I dorsodistal, occupying 15% of length of segment. Coxa II with spinose process on anterodorsal margin. Ambulacra with two claws of medium strength. Legs and setation otherwise undistinguished.

**Male (Figs 3-4, 7-8):** Capitulum as in ♀, except for secondary sexual dimorphism of chelicerae, which are 220 $\mu$ m long overall. Basal segment, middle segment (details and length of reduced fixed digit not clear) and spermatodactyl (105 $\mu$ m long) of same proportions as in *L. warnekei*.

Idiosoma 880 $\mu$ m long, calculated to be 725 $\mu$ m wide (engorged, ruptured on one side). Dorsal shield entire, rounded humerally, then gently tapering to broadly rounded posterior margin; 735 $\mu$ m long, 405 $\mu$ m wide at humeri; probably normally with 28 pairs of setae (18 podonotal, 10 opisthonotal; *Z*<sub>5</sub> absent on one side); surface as in ♀, but with 11 pairs of pores (including an enormous pair humerally, Figs 4, 7). Dorsal cuticle with pair of large pores posterolaterally, several pairs of small pores and about 34 pairs of setae.

Tritosternum as in ♀. Holoventral shield 615 $\mu$ m long, 175 $\mu$ m wide behind coxae IV; with texture as in ♀; with setae *st*<sub>1-3</sub>, *mst*, *g*, *v*<sub>1-3</sub>, *aa* and *pa*, and four pairs of pores, present (metasternal pore absent on one side). Anterior pair of endopodal shields fused into sternal portion of holoventral shield, posterior pair free as in ♀. Incompletely divided metapodal shields present. Ventral cuticle with about 18 pairs of setae of increasing length posteriorly and four pairs of small pores. Stigmata and peritrematalia as in ♀.

Legs as in ♀, except that seta *pv*<sub>2</sub> on tarsi III-IV is modified as in *L. intermedius*.

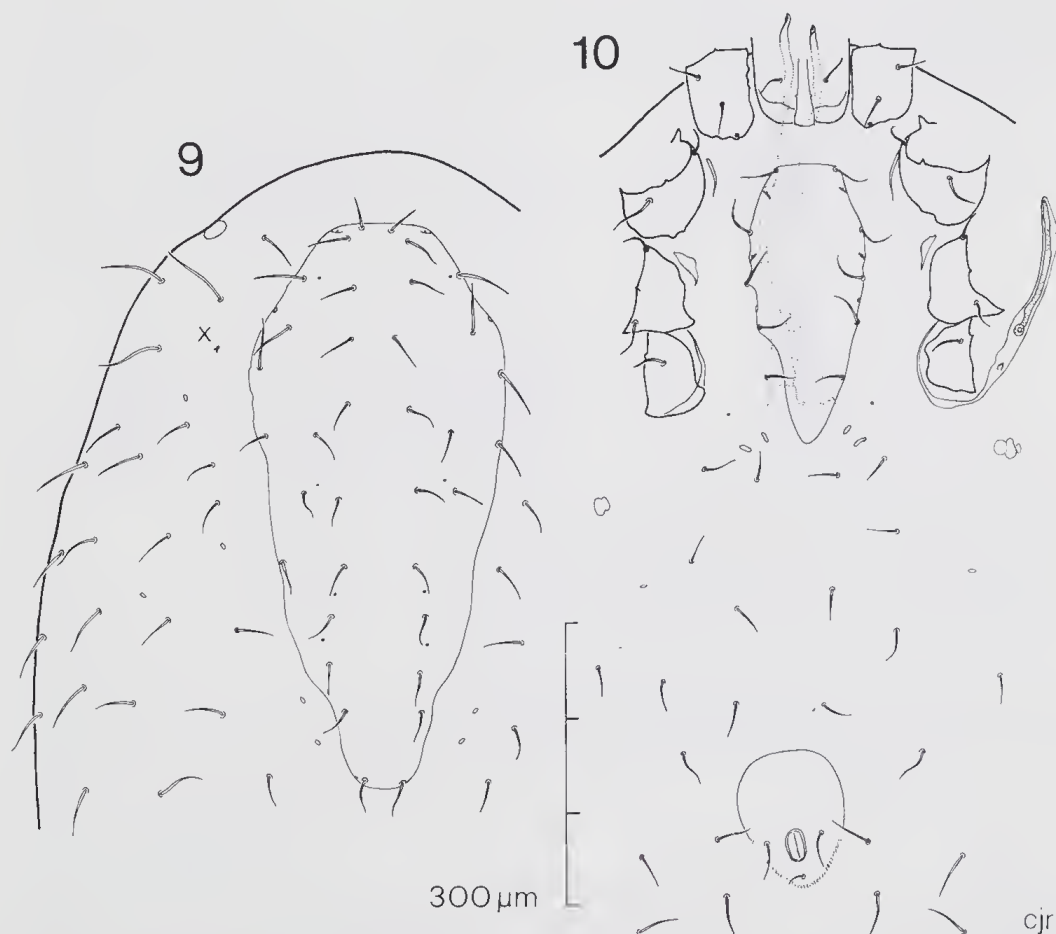


Figs 7-8: *Liponyssoides lukoschusi* sp. nov., ♂. 7, Dorsum. 8, Venter.

**Deutonymph (Figs 9-10):** Capitulum and legs (including chelicerae and seta  $pv_2$  on pedal tarsi III-IV in premale) as in ♀.

Idiosomatal measurements unavailable since all specimens were grossly engorged, and ruptured during mounting procedures. Dorsal shield entire, 590-635 μm long, 270-280 μm wide (prefemale); 530-560 μm long, 230-250 μm wide (prefemale, as evidenced in smallest specimen by enormous humeral pores on enclosed adult); with 18 pairs of setae (12 podonotal, six opisthonotal;  $j_4$  absent on one side of one specimen;  $Z_1$  occasionally absent on one side—as in Fig. 9— or both); surface with texture predicting that of ♀, and only six pairs of pores detected. Dorsal cuticle with two pairs of large pores (anterior pair on shield in adult, and marked “x” in Fig. 9; posterior pair on torn cuticle behind shield, and not drawn), several pairs of small pores (some of which, as in ♀, may be usurped by posterolateral portion of shield), and many setae.

Tritosternum as in ♀. Sternal shield 285-310 $\mu$ m long, 115-120 $\mu$ m wide at setae  $st_2$  (prefemale); 245-260 $\mu$ m long, 105-110 $\mu$ m wide (prefemale); with texture predicting that of ♀ (at least in posterior third); with setae  $st_{1-3}$ ,  $mst$  and three pairs of pores submarginal ( $mst$  on isolated shieldlet on one side of premale); setae  $g$  usually free of shield, but one or occasionally both touching on margin; genital complex further represented by pair of pores and two pairs of shieldlets. Anal shield 135-145 $\mu$ m long, 100-105 $\mu$ m wide (prefemale), 120-125 $\mu$ m long, 90-95 $\mu$ m wide (prefemale); virtually textureless, except for narrow cribrum; otherwise as in ♀. Two pairs of endopodal shields present. Irregular metapodal shields present. Ventral cuticle with numerous setae of increasing length posteriorly and some small paired pores. Stigmata and peritrematalia predicting those of ♀, but with anteriormost shieldlet still free in dorsal cuticle (Fig. 9).

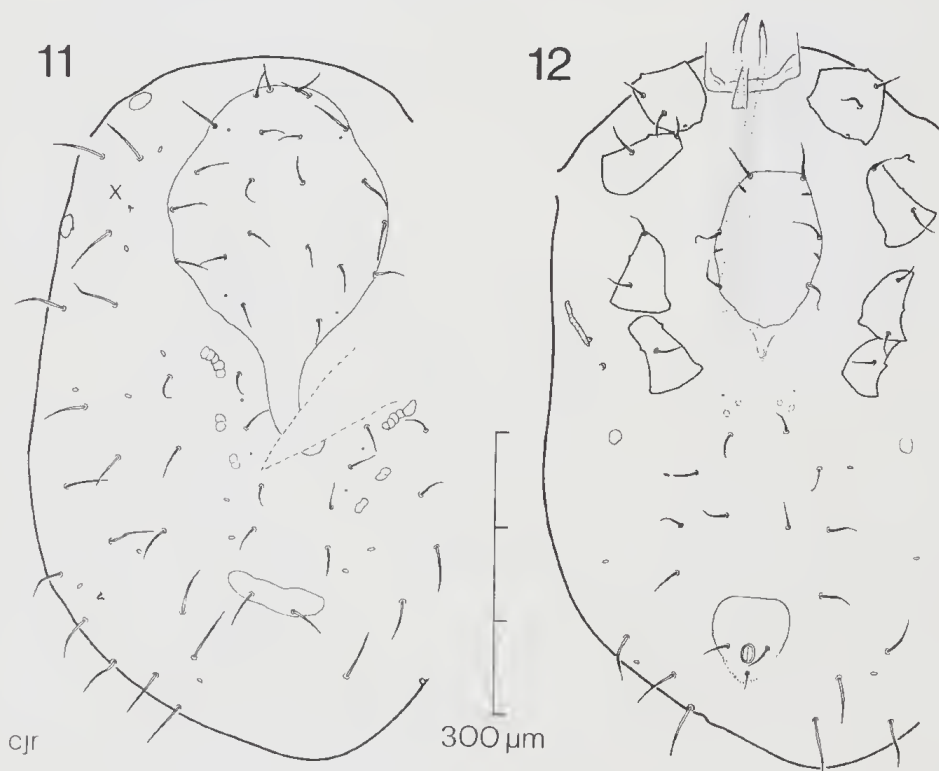


**Figs 9-10:** *Liponyssoides lukoschusi* sp. nov., dn (cuticle behind dorsal and anal shields omitted). 9, Dorsum. 10, Venter.



**Protonymph (Figs 11-12):** Capitulum and legs predicting those of ♀, holotrichous (seta *al*<sub>1</sub> on palpal genu strongly clavate).

Idiosoma 715µm long, calculated to be 505µm wide (partly engorged). Podonotal shield 305-365µm long (including posteromedian extension reaching back to level of setae *J*<sub>2</sub>), 205-230µm wide; podonotum holotrichous, with 11 pairs of setae on shield and five pairs on cuticle; surface of shield virtually textureless, and only two pairs of pores detected. Accepting that five pairs of setae shown posterolaterally in Fig. 11 are from ventral series due to slight rotation of specimen, opisthonotum also holotrichous, with 14 pairs of setae, three pairs of mesonotal shieldlets and transverse pygidial shield (20-25µm long, 105-115µm wide) bearing setae *J*<sub>5</sub>. Dorsal cuticle also with two pairs of small pores (one each between setae *J*<sub>1-2</sub> and *J*<sub>2-3</sub>), two pairs of large pores (anterior pair on shield in adult, and marked "x" in Fig. 11), and about 10 pairs of small pores.



**Figs 11-12:** *Liponyssoides lukoschusi* sp. nov., pn. 11, Dorsum. 12, Venter.

Tritosternum as in ♀. Sternal shield 155-165µm long, 95-110µm wide; textureless, with setae  $st_{1-3}$  and two pairs of pores submarginal; posterior margin somewhat irregular. Genital complex represented only by two pores and two pairs of weak shieldlets. Anal shield 85-95µm long, 65-75µm wide; textureless, except for narrow cribrum; otherwise as in ♀. Subcircular metapodal shields present. Ventral cuticle with about 13 pairs of setae of increasing length posteriorly (including five pairs shown posterolaterally in Fig. 11) and three pairs of small pores. Stigmata provided with short peritremes; peritrematal shields represented by three elements: pore behind stigmata and two shieldlets (one lateral, with pore on dorsal margin; one dorsal).

**Larva:** Unknown.

### Hosts and localities

On tawny frogmouth, *Podargus strigoides* (Latham) (Caprimulgiformes: Podargidae), Beagle Bay, W.A., 24, 26.VIII.1976 (holotype ♀, allotype ♂, 7 paratype ♀♀, 10 morphotype dn, 4 morphotype pn). In WAM (including holotype and allotype), FMNH, QIMR, CU.

On brown tree-creeper, *Climacteris picumnus* Temminck (Passeriformes: Certhiidae), Culgoa River, Q., 11.II.1969, B.C. Nelson (3 dn, 3 pn, not types). In QIMR.

### *Dermanyssus hirundinis* (Hermann, 1804)

This species is widely distributed in the Holarctic on various birds, but, since its principal hosts [swallows (Passeriformes: Hirundinidae), see Evans & Till (1962) and Moss, Mitchell & Johnston (1970)] are so mobile, it may be regarded as normally resident in, rather than recently introduced to, Australia. The first specimen listed below was recognised after Domrow (1963) went to press, but it and the other two specimens now added have since been checked against the keys, descriptions and setational formulae of Evans & Till (1966) and Moss (1967, 1968, 1978), with which they agree.

In Australia, the outer parts of caves are used as nesting sites by the fairy martin, *Hylochelidon ariel* (Gould) (Hirundinidae), and this may *possibly* be the host of the Western Australian material now recorded.

### Hosts and localities

On yellow-throated honeyeater, *Meliphaga flavicollis* (Vieillot) (Passeriformes: Meliphagidae), Cascades, Hobart, Tas., 15.I.1961, B.C. Mollison (1 ♀). In QIMR.

Free-living, Arramall Cave, Arrowsmith River, W.A., 3.XI.1973, J.W.J. Lowry (2 dn). In QIMR.

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### *Illustrations*

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